CITY OF BATTLEFIELD
DESIGN STANDARDS FOR
PUBLIC IMPROVEMENTS

ADOPTED OCTOBER 15, 2002

CITY OF BATTLEFIELD DESIGN STANDARDS
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STANDARD DRAWINGS AND FIGURES

CHAPTER 1 - SANITARY SEWERS

A. GENERAL

1. Materials. All materials used in the construction of sanitary sewers shall conform to the latest revision of the City of Battlefield Technical Specifications for Public Improvements unless specifically designated otherwise by special provision drawings and prior approval is obtained.

2. Discrepancies. Where discrepancies between standard details, drawings and/or special provisions occur, the special provisions shall govern.

3. Structures. Whenever possible, structures shall be constructed as shown in the standard details. Structures other than those shown in the standard details shall be considered to be special structures and must be designed and detailed by the design engineer.

4. Construction on Fill. Where a sewer must be constructed on fill, a profile of the original undisturbed ground line along sewer centerline shall be shown. All sewers to be constructed on fill must have a special design approved by the City of Battlefield.

5. Tendering. Tendering of the sanitary sewer line and appurtenances must be made prior to acceptance of the sanitary sewers by the City.

B. SANITARY SEWER DESIGN

1. Design Period. Sanitary sewer systems must be designed for the estimated ultimate tributary population. Consideration should be given to the maximum anticipated capacity of institutions and industries.

2. Design Factors. In determining the required capacities of sanitary sewers the following factors shall be considered:

   a. Maximum hourly quantity of sewage.

   b. Additional sewage volume or waste from industrial plants.

   c. Ground water infiltration.

3. Design Basis.

a. Per Capita Flow. Sewer systems shall be designed on the basis of the maximum hourly flow of three (3) times the average daily per capita flow of sewage. In no case shall the average daily per capita flow be considered less than one hundred (100) gallons per day. This figure is assumed to cover normal infiltration, but an additional allowance should be made where ground conditions are known to be unfavorable and industrial wastes are present.

b. Alternative Method. When deviations from the foregoing per capita rates are warranted, a brief description of the proposed procedure to be used for the sewer design shall be included. The City of Battlefield recommends 2,500 to 3,000 GPD per acre for single-family gross area exclusive of sewage or other waste from industrial plants.

4. Design Details.

a. Minimum Size. No public sewer shall be less than eight inches in diameter.

b. Location. Sewers shall be placed in street right-of-way where feasible. Plans shall show the stationing of all in-line tees.

c. Depth. Sewers shall be designed deep enough to prevent freezing, and to allow house connections to cross under water mains at such an elevation that the bottom of the water main is at least eighteen (18) inches above the top of the sewer line. If the proposed sewer is parallel to a water main, it shall be designed to provide a minimum 18-inch vertical clearance or a minimum 10-foot horizontal clearance from the water main. Unless approved by the City of Battlefield, no sewer shall be designed and/or constructed that will not provide a minimum depth of four (4) feet to top of pipe. All PVC sewers over 12’ deep shall be SDR 21, Class 200 pipe. All sewers over 12’ deep shall have a minimum of 12” of aggregate bedding material over the top of the pipe.

d. Slope. All sewers shall be designed and constructed so as to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Mannings formula using an “n” value of 0.013.

e. Slope calculations and detailing. The slope on all sewer lines shall be calculated from inside wall of manhole to inside wall of manhole.

The following are the minimum slopes, which should be provided; however, slopes steeper than these are desirable.

Sewer Size	Minimum Slope in Feet per 100 Feet
8”	0.40
10”	0.28
12”	0.22
14”	0.17
15”	0.15
16”	0.14
18”	0.12
21”	0.10
24”	0.08

The velocity of flow in sewers shall not exceed 12 feet per second. If necessary, a drop manhole shall be provided to reduce the velocity. Sewers shall be laid with uniform slope between manholes. The maximum slope for all main line sewer pipes shall be 10%. The minimum slope for all laterals shall be ¼ inch per foot, unless otherwise approved.

f. Loading. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench.

g. Grade through Manholes. A drop of 0.2 feet shall be shown through manholes. The flow line of new sewer lines coming into a main sewer manhole should be at least one half the diameter of the trunk sewer above the flow line of the trunk sewer.

h. Increasing Size. When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient.

i. Alignment. Sewers in streets should be placed in or near the center of the street where possible. Sewers located at back property lines should be about two feet to one side of the property line and on the opposite side from pole lines or other utilities. The ends of sewer lines should

extend at least fifteen feet beyond the property line of the last lot served, to provide room for the house connection with a tee below the manhole. Cutting corners and running diagonally across streets is not allowed.

A minimum permanent easement of 5' either side of sewer is required. A temporary construction easement shall be provided, as necessary. All crossing and/or cutting of streets must be backfilled with granular material. All sewers with a trench wall within two feet of the back of the street curb shall be backfilled with granular material.

5. Relation to Water Mains or Storm Sewers.

a. Horizontal Separation. Wherever possible, sewers should be laid at least 10 feet, horizontally, from any existing water main or storm sewer. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main or storm sewer if:

(1) It is laid in a separate trench, or

(2) It is laid in the same trench with the water mains or storm sewer located at one side on a bench of undisturbed earth, and

(3) In either case the elevation of the top (crown) of the sewer is at least 18" below the bottom (invert) of the water main or storm sewer.

b. Vertical Separation. Whenever sanitary sewers must cross under water mains or storm sewers, the sanitary sewer shall be laid at such an elevation that the top of the sanitary sewer is at least 18" below the bottom of the water main or storm sewer. When the elevation of the sanitary sewer cannot be varied to meet the above requirement, the water main or storm sewer shall be relocated to provide this separation.

When it is not feasible to obtain proper horizontal and vertical separation as stipulated above, the sewer must be constructed of SDR 21, Class 200 pressure water line pipe and must be air tested at a pressure not less than four (4) pounds per square inch for five (5) minutes to assure water tightness. A manhole must be located at each end of the pressure pipe; and the near side of the manholes can be no closer than ten (10) feet from the water main.

No water line shall pass through or come into contact with any part of a sanitary sewer manhole.

6. Manholes.

   a. Location. Manholes shall be installed at all changes in grade, size or alignment, at all intersections, and at intervals of not more than 400 feet for all sewers.

   b. Drop Type. A drop pipe shall be provided for a sewer entering a manhole at an elevation of 24" or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert shall be filleted to prevent solids deposition; manholes, where the difference in elevation between the incoming sewer and the manhole invert is greater than 24 inches but less than 36 inches will not be allowed. Special design is required for connection to manholes with interior linings.

   c. Diameter. The minimum diameter of manholes shall be 48 inches (4 feet), and shall conform to the latest revision of the City of Battlefield Technical Specifications. All inside drop manholes shall have a minimum diameter of 60 inches (5 feet).

   d. Manhole Covers. All sanitary sewer manhole covers shall be Type "A," non-rocking.

   e. Stationing and Elevation. Stationing and elevations should be shown at all M.H. locations.

7. Lampholes. Lampholes may be permitted upon the approval of the City of Battlefield. Lampholes will be permitted only in cases where the slope of the land will not permit a future extension of the sewer beyond the proposed lamphole. The maximum length to the nearest manhole shall not be greater than 150 feet. Lampholes will not be permitted within street surfaces.

C. DRAWINGS AND DOCUMENTS TO BE SUBMITTED

1. Sewer Drawings. Sewer drawings shall be prepared on plans separate from other utilities.

   a. Plan. The plan shall be at the top of the drawing. Standard symbols shall be used. A standard north arrow shall be located on each sheet (pointing up or to the right).

(1) Scale. Scale shall be 1" = 40' horizontal for undeveloped areas and 1" = 20' for developed areas.

(2) Method of Indicating Location. Sewers and manholes within streets and adjacent developed areas shall be located in plan by dimensions from property markers or other well-defined physical features.

b. Profile. The profile shall be shown under the plan.

(1) Scale. Scale shall be 1" = 4' vertical, and 1" = 40' horizontal for undeveloped areas and 1" = 20' for developed areas.

(2) Grades. Established elevations of existing manholes shall be obtained from field surveys. Existing ground and proposed pavement over sewer shall be shown and labeled. Existing or proposed building floor elevations or sufficient ground elevation 100 feet either side of centerline shall be shown to determine required depth and slope of service lines.

c. Utilities. Existing and proposed utilities shall be accurately and clearly shown in plan and profile. Elevations of existing utilities shall be obtained where possibility of conflict exists.

d. Location and Design Information. A cover sheet shall be Sheet No. 1 of the drawings, indicating the entire area to be served by the proposed sewers and indicating the sheet number on which each segment of sewer line is drawn. The scale shall be 1" = 100'. When this cannot be done without attaching an extra drawing, then the scale will be 1" = 200'. Also, all lots, blocks, and the location of proposed sewer lines shall be known. When the cover sheet will not show at least two well-known streets or routes, a small location map shall be added to the cover sheet showing the location of the project. Benchmarks based on USGS datum shall be shown on the drawings. The City of Battlefield will review the plans to determine its compatibility with the entire drainage area. The developer or owner's name shall be shown on the cover sheet along with the subdivision name.

D. LIFT STATIONS

1. General.

a. A sewage lift station shall consist of a wet well, sewage pumps, control systems, electrical systems (normal and emergency), superstructures, site security systems, grading, and access.

The purpose and goal of a lift station is to serve as a sewage collection point for a development and to pump that sewage to a gravity line serving the area in a safe, economical, and easily-maintained manner.

2. Buildings and Grounds.

a. Flooding. Sewage pumping stations shall not be subject to flooding due to storm water runoff. A suitable superstructure located off the right-of-way of streets and alleys shall be provided.

b. Fencing. A fence surrounding the station site shall be provided. The fence shall be eight (8) feet high (minimum) with a twelve (12)-foot wide, double-leaf gate. The fence shall be galvanized chain link except where subdivision rules require a wooden privacy fence. Supporting posts for all types of fences shall not be more than eight (8) feet apart and be concrete encased below grade. Minimum bury depth of posts to be two and one-half (2-½) feet. Wooden fences shall be constructed of pressure treated or other approved weather resistant wood. Wooden support posts shall be 4" x 4" minimum. The gate is to be located so that entranceway does not go over manholes. The pump station and generator unit is to be easily accessible for maintenance from entranceway. The gate is to be set back twenty-five (25) feet from edge of road.

c. Surfacing of Lift Station Area. The area inside the fence must be constructed of four (4) inches of Type 1 aggregate, compacted according to City Specifications, on a four (4) mil polyethylene sheeting placed over the entire enclosed area. This sheeting shall have one (1)-inch diameter perforations spaced not more than two feet in each direction. Prior to placing the sheeting, the soil to be covered is to be treated with a soil sterilant Diuron (Karmer by DuPont), or equal, and applied as directed by the manufacturer.

d. Accessibility to Site. The pump station must be accessible by an acceptable all-weather, hard-surface road meeting the same requirements as other roads in the development. Junction of pump station road and public street shall have a minimum sixteen (16)-foot-long culvert of acceptable diameter in ditch if necessary.

e. Outside Lighting. An outside weatherproof pole-mounted, high-intensity discharge lighting fixture of not less than 175 watts with an electrical eye with dusk-to-dawn operation shall be provided. The light is to be of the high-pressure sodium type with electric eye for dusk-to-dawn operation.

f. Switching Gear and Controls. Generator unit, switching gear, and controls to be mounted inside a weatherproof building with four (4) feet (minimum) clearance on each side of generator unit, with a minimum height of eight (8) feet. The building may be a wood frame, metal or masonry building mounted, and attached to a six-inch non-reinforced concrete floor.

3. Design. The following items should be given consideration in the design of sewage pumping stations:

a. Type. Sewage pumping stations may be either suction-lift type or submercible. When total suction lift exceeds fifteen (15) feet, only the submercible type will be permitted. When GPM from one pump is 700 GPM or greater, a dry well/wet well-type station would be acceptable.

b. Structures.

(1) Separation. Wet and dry wells including their superstructure shall be completely separated.

(2) Pump Removal. Provision shall be made to facilitate removing pumps and motors.

(a) Submersible pump stations shall have a slide coupling and guide rails lifting system. A stainless steel lifting cable, with one end permanently attached to the pump-lifting lug and the other end secured at grade level, shall be provided.

(b) Dry well/wet well stations shall have a hoist and trolley system to lift and move the pumps to the access

opening.

(c) Suction lift stations shall have lifting arm for removing motor and pump from base.

(d) Where pump station is enclosed in a building, equipment shall be provided for moving pumps and motors to the access doorway.

(3) Access. Suitable and safe means of access shall be provided to dry wells of pump stations and shall be provided to wet wells containing either bar screens or mechanical equipment requiring inspection and maintenance. Stairways or ladders exceeding fifteen (15) feet shall have rest landings at vertical intervals not exceeding ten (10) feet.

c. Pumps.

(1) Duplicate Units. At least two (2) pumps shall be provided. If only two (2) units are provided, they must have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow. Where more than two (2) units are provided, each shall be designed to fit maximum flow conditions and must be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum sewage flows.

(2) Protection Against Clogging. Where the size of the lift station is 700 g.p.m. or greater, a trash rack located below floor level shall be provided. Where screens are located below ground, facilities must be provided for handling screenings.

(3) Pump Openings. Pumps shall be capable of passing spheres of at least three (3) inches in diameter. Pump suction and discharge openings shall be at least four (4) inches in diameter.

(4) Priming. The pump shall be so placed that under normal operating conditions it will operate under a positive suction head, except as specified for suction-lift pump stations. Each suction-lift pump shall have a priming system independent from other pumps.

(5) Intake. Each pump shall have an individual intake. Wet well

design shall be such as to avoid turbulence near the intake.

(6) Dry Well Dewatering. A separate sump pump shall be provided in the dry wells to remove leakage or drainage with the discharge above the overflow level of the wet well. Water ejectors connected to a potable water supply will not be approved. All floor and walkways surfaces shall have an adequate slope to a point of drainage.

(7) Submersible Pump Seals. Tandem mechanical seals are required on submersible pumps.

d. Valves. A shut-off valve shall be placed on suction and discharge lines of each pump. A check valve with external arm shall be placed on each discharge line between the shut-off valve and the pump. An external arm check valve is required with a lever-operated micro switch for telemetering purposes. These valves shall be located outside of the wet well and shall be readily accessible for repairs.

e. Wet Wells.

(1) Grit. Where it may be necessary to pump sewage prior to grit removal, the design of the wet well should receive special attention and the discharge piping shall be designed to prevent grit settling in pump discharge lines of pumps not operating.

(2) Divided Wells. Where continuity of pumping station operation is required, consideration shall be given to dividing the wet well into two sections, properly interconnected, to facilitate repairs and cleaning.

(3) Floor Slope. The wet well floor shall have a minimum slope of one (1) to one (1) to the hopper bottom.

f. Ventilation. Adequate ventilation shall be provided for all pump stations. Where the pump pit is below grade, mechanical ventilation is required. In dry well/wet well stations, mechanical ventilation is required when screens or other mechanical equipment requiring maintenance or inspection is located in the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. In pits over fifteen (15) feet deep, multiple inlets and outlets are required. Dampers shall not be used on exhaust or fresh air ducts, and fine screens or other obstructions in air ducts shall be avoided to

prevent clogging. Switches for operation of ventilation equipment shall be marked and located at grade level. Ventilation equipment and lighting shall be energized when lid is open on dry well type stations. The fan wheel shall be fabricated from non-sparking material. Automatic heating and dehumidification equipment is required when station is located below grade level.

(1) Wet Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least twelve (12) complete air changes per hour; if intermittent, at least thirty (30) complete air changes per hour. Such ventilation shall be accomplished by introduction of fresh air into the wet well by mechanical means.

(2) Dry Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six (6) complete air changes per hour; if intermittent, at least thirty (30) complete air changes per hour.

g. Water Supply. Potable water shall be supplied; however, there shall be no physical connection between the potable water supply and a sewage pumping station. Potable water supply line shall not be smaller than one-half (1/2) inch. A freeze-proof hydrant with hose bib shall be located within ten (10) feet of pumping station but not in the traffic path.

h. Dry Well Covers and Lids. Covers shall be made of lightweight, weather-resistant material and constructed so that it may be easily opened by one person. If force required to open cover is in excess of fifty (50) pounds, shock absorbers or opening springs must be provided.

i. Spare Parts. Pump stations are to be provided with two (2) mechanical seals and two (2) gasket kits to install with seals. If seal filters are used, six (6) spares are to be included. Two (2) complete sets of contacts and coils for starters and one (1) spare alternator relay or timer shall also be furnished.

j. Force Main Interface. A force main interface consisting of piping, a 45-degree "Y," 45-degree elbow, and flanged, full-flow valve shall be provided.

(1) All pipe and fittings shall be the same material and the same size as the force main.

(2) The interface shall be constructed within a four-foot manhole of required depth located external from but adjacent to the pump station.

(3) A standard manhole frame and cover shall be installed flush with finished grade.

k. Special Requirements for Suction-Lift Pump Stations. In addition to the previously mentioned requirements for suction-lift stations, the following shall apply:

(1) Priming. Suction-lift pumps shall have a reliable record of satisfactory operation and be installed with a single piece suction line braced to the side of wet well. Priming shall be by dual vacuum systems independent of each other.

(2) Capacity. Approval will be restricted to installations where total suction-lift does not exceed fifteen (15) feet.

l. General Electrical Requirements. All electrical equipment and wiring shall comply with the latest revision of the National Electrical Code. Particular attention should be given to electrical equipment enclosed in places where gas may accumulate (hazardous areas). Submercible pumps are considered to be in a hazardous area and shall be rated explosion proof by Underwriters Laboratory. This rating shall include pumps, removal systems, and controls. Vacuum primed pump controls systems must be operated through intrinsically safe relays for hazardous locations. All conduit shall be of galvanized rigid type and shall be installed below grade wherever possible. Dry-type transformers for 110-Volt utility service and control systems power shall be provided.

(1) Primary power to the station shall be no higher than 480 Volt, 3 Phase, and shall be provided by connection to a commercial utility service. A single disconnect is to be provided between the pump station and the utility.

(2) Emergency Operation. Provision of an emergency power supply for pumping stations shall be made, and may be accomplished by connection of the station to a second independent public utility source or by provision of in-place engine generator.

m. Controls. Control of pumps shall be by floating mercoid switches, normally open type. Minimum of four (4) switches shall be provided. The switches shall be used to indicate "PUMPS OFF," "FIRST PUMP ON," "SECOND PUMP ON," "HIGH LEVEL ALARM." The control panel shall include automatic pump alternation to equalize operating time on all duplex components. Elapsed time meters to be calibrated in one-tenth (0.1) hour increments on all pumps. Provisions shall be made to bypass the alternator in the event that either pump is out of service for maintenance. Motor starter coils to be rated 100 Volts, 50 Hertz. On larger lift station installations other control systems may be required. Hand-off-auto switch and elapsed time meters to be visible and operable through control panel door.

n. Alarm Systems. Alarm systems shall be provided for all pumping stations. Equipment shall be a microprocessor base with synthesized speech and design to operate on a single-party, pulse-dial telephone circuit. All necessary equipment shall be provided to transmit the following alarms: 1. High wet well liquid level; 2. Power failure; 3. Transfer to emergency power source; 4. Generator failure; 5. Pump No. 1 running; 5. Pump No. 2 running. Other alarm features may be required based upon pump station design.

o. Power Generating Equipment.

(1) General. The power module shall consist of an engine, generator, and control panel assembly, all mounted with antivibration mounts onto a fabricated steel skid base. An automatic transfer switch may be mounted separately or in the control panel assembly to automatically switch to emergency power in the event of commercial power failure. The engine generator shall be sized for starting one (1) pump and all auxiliary loads, with an additional 50% overload capacity. The complete power module shall be factory assembled and factory tested to ensure that all controls and protective devices are in proper working order. The motor starting capability shall be tested by a simulation of the exact operating load, with certified test results provided. The power module must be

coordinated with the pump station.

(2) Engine. The engine shall be multi-cylinder, 4-cycle, and water-cooled. Water-cooled engines shall be provided with mounted radiator, fan and water pump with anti-freeze added to the cooling system to bring it to 20 degrees F. below zero protection. The fuel system shall consist of a carburetor with an automatic choke and an electric shutdown solenoid, and a dry-type air cleaner. The engine shall run on any reputable commercially available natural gas with minimum low-heat value of 950 BTU/cubic foot. The governor shall be capable of 3-5% speed regulation from no load to rated load. The lubrication system shall be force fed by gear oil, pumped to all connecting rods, main bearings, and rocker arms. Oil filter shall be spin-on, full-flow type. Engine may be operated continuously when tipped up to 15 degrees in any direction. The engine starting system shall consist of a 12-volt battery and a 12-volt Bendix-type drive, solenoid-equipped electric starter. The charge on the battery shall be maintained by a 32-amp or larger charging alternator. A water-cooled engine shall be equipped with a jacket water heater to aid in starting and engine longevity.

(3) Alternator. The alternator shall be a full 3-phase, 4-pole, self-excited, brushless, revolving field type with static exciter. It shall be self-regulated and designed specifically for motor starting application. The alternator shall be directly connected to the engine flywheel housing and driven through a semi-flexible driving flange to ensure permanent alignment. It shall have drip-proof construction. Voltage regulation shall be within plus or minus 5% of rated voltage from no load to full load. Insulation shall be Class F with a 70 degree C maximum temperature rise. A completely wired and assembled generator control panel shall be furnished. It shall contain the following items: 1. One ammeter with phase selection switch; 2. One voltmeter with phase selection switch; 3. One vibrating-vane type frequency meter; and 4. Integral battery charger 0-10 amp. 6. A line circuit breaker for alternator output leads.

(4) Automatic Transfer Switch. The automatic transfer switch shall be a mechanically-held, double throw. The transfer action must be completely electrical and not rely on springs or counterweights. Operating coils must be momentarily

energized from the source to which the load is being transferred. The switch must be interlocked both mechanically and electrically to prevent both sources from feeding the load at the same time. Electrical operation must not allow a neutral position. The main contacts of the transfer switch shall meet with a rolling and wiping action. They shall be copper with cadmium plating up to and including 100 amps and silver plating on all sizes above 100 amps. They shall be rated for all classes of load to 480 volt AC and equipped with blowout coils and arc chutes. They shall have air inrush current rating of 20 times rated current and an interrupting capacity of 1.5 times rated current. The transfer switch shall include auxiliary contacts to provide for the locking out of the standby pump and connection to alarm system. It shall also have three voltage-sensitive relays with dropout 70-80% adjustable pickup at 90%. Upon sensing of under-voltage condition, the generator startup and transfer sequence shall be initialed automatically. Provision shall also be made to manually initiate the sequence.

(5) Engine Control Panel. The engine control panel is to include five (5) ten-second-on/10-second-off cranking cycles, a switch for testing the automatic operation, a switch for deactivating the automatic operation, an oil pressure gauge, coolant temperature gauge, battery charging DC ammeter, elapsed time meter, indicating lights for fail-to-start, line-power-on, and standby-power-on, protective shut-down, with indicating lights for engine overspeed, low oil pressure, overload, high coolant temperature, manual start-run-stop switch, 0-60-second time delay on transfer Normal to Emergency, 0-30-minute time delay on transfer Emergency to Normal, 0-5-minute time delay after transfer to normal for engine cool down, contacts to signal emergency power on, contact to signal fail-to-start, contact to signal protective shut-down and fail-to-start, and a weekly exercise timer.

(6) Placement. The unit shall be bolted in place. Facilities shall be provided for unit removal for purposes of major repair or routine maintenance.

(7) Engine Location. The unit internal combustion engine shall be located above grade with exhaust muffler and outlet located outside of housing. The muffler system shall be residential type or better. Exhaust sleeve from building to be approved by

National Fire Protection Association Code.

(8) Engine Cooling Ventilation.

(a) Cooling air shall be provided by venting from the outside to the engine. The vent shall be properly located and sized to assure an adequate air supply. Vents to have screen on inside to prevent bugs and birds from entering.

(b) Engine housing shall have adequate ventilation to maintain a safe equipment operating temperature.

(9) Emergency Power Generation. All emergency power generation equipment shall be provided with instructions indicating the essentiality of routinely and regularly starting and running each unit at full load.

(10) Generator Spare Parts. Generator spare parts are to include one (1) spare circuit board of each type used, or provide a means for bypassing and testing circuits.

4. Acceptance of Lift Station.

(a) Shop Drawings. Shop drawings shall be submitted on lift station, stand-by power source and structures, and be approved prior to installation. Three (3) copies are required.

(b) Testing. Prior to acceptance of lift stations by the City, testing of each equipment item shall be required in the presence of the Contractor, a City representative, and the equipment manufacturer's representative. Final acceptance will not be made until all deficiencies are corrected and retesting is performed.

(c) As-Builts. Prior to acceptance of operation of lift station, generator units, and other related appurtenances by the City, one (1) set of mylar reproductibles and three (3) sets of prints of "As-Builts" shall be submitted.

(d) Operation and Maintenance Manuals. Four (4) complete sets of operational instructions shall be provided to include emergency procedures, maintenance schedules, maintenance manuals, and service manuals on all equipment. Special tools and such spare parts as may be necessary shall be furnished to the City for the facilities to be accepted.

E. FORCE MAINS

1. Velocity. At design average flow, a cleansing velocity of at least four (4) feet per second shall be maintained.

2. Air Release Valve. An APCO Sewage Air Release Valve Model 401, or approved equal, shall be placed at high points in the force main to prevent air locking. A standard four-foot diameter manhole with standard frame and cover to be installed around force main and relief valve for maintenance access to valve.

3. Connection to Gravity System. The force main shall connect to the gravity sewer system at a point not more than two (2) feet above the flow line of the receiving manhole.

4. Design Pressure. The force main pipe and fittings shall be designed to withstand normal pressure and pressure surges.

5. Thrust Blocks. Concrete thrust blocking shall be provided at all bends 22 ½ degrees or greater.

6. Force Main Pipe. All force main pipe shall be P.V.C. AWWA C-900; however, SDR-21, Class 200 pipe will be required unless calculations are provided to verify that a lesser class of pipe is adequate. Pipe types less than Class 200 must be shown on the plans.

7. Depth. Force main pipe shall be designed and so constructed to provide a minimum depth of three (3) feet of cover over the top of the pipe.

8. Casing. Force mains designed to cross public streets must be encased with either reinforced concrete pipe or steel casing of adequate size to allow for future removal of the force main pipe.

9. Testing. Testing of the force main is required in accordance with the requirements of AWWA C-600. Testing pressure shall be: Total Design Head x 0.433 x 1.5. (Note: This must be shown on the plans.)

CHAPTER 2 - STORMWATER

A. GENERAL PROVISIONS

1. Scope. These design standards set forth the minimum requirements for design of storm drainage facilities on public right-of-way and private property in the City of Battlefield, Missouri.

   These standards shall apply to all subdivisions for which preliminary plats approved after the date of passage by the City of Battlefield, or building permit submittals, or grading permit applications which are received after the date of passage by the City of Battlefield.

2. Permits Required

   a. Grading Permit

      Storm drainage facilities shall not be constructed or altered without review and approval of plans by the City of Battlefield and issuance of a Grading Permit. The procedure for obtaining a grading permit is outlined in Section I.3.b.

   b. National Pollutant Discharge Elimination System (NPDES) Stormwater Permit

      Provisions of the 1987 Clean Water Act require that certain stormwater discharges obtain an NPDES Stormwater Permit. In Missouri, these permits are administered by the Missouri Department of Natural Resources.

      NPDES stormwater permits are required for land disturbance activities when five acres (5) or more are disturbed. See Section I.4.a for permitting procedures for sites requiring an NPDES land disturbance permit.

   c. "404" Permit

      For certain activities which involve the discharge of dredged or fill materials into the waters of the United States, a Department of the Army permit may be required as set forth in Section 404 of the Clean Water Act. Rules for "404" permits are contained in 33 CFR Parts 320 through 330 of the Code of Federal Regulations.

Determination of applicability for Section 404 requirements are generally made by the Little Rock District office of the Corps of Engineers for the James River and its tributaries which are located within the White River drainage basin.

Questions regarding Department of the Army Permits for the James River and tributaries may be directed to:

Northwest Regional Field Office
Little Rock District
U.S. Army Corps of Engineers
4600 State Highway 65, Suite A
Branson, MO 65616
Phone: 501-324-6017

3. Coordination with Other Jurisdictions. Where proposed storm drainage facilities are located on property adjoining other local government jurisdictions, design of storm drainage facilities shall include provisions to receive or discharge storm water in accordance with the requirements of the adjoining jurisdiction, in addition to meeting City of Battlefield requirements.

   In these cases two (2) additional sets of plans shall be submitted and will be forwarded to the adjoining jurisdiction for review and comment.

4. Coordination with Transportation Facilities & Utilities. Planning and design of proposed storm drainage facilities must be compatible with proposed or existing utilities, highways, streets, roads, railroads, and other public facilities.

   Where other public facilities may be affected by proposed storm drainage facilities, plans for storm drainage facilities shall be forwarded to the appropriate agency for review and comment.

   No grading or construction of storm drainage facilities may commence without prior notification of the Missouri One Call utility warning system at 1-800-DIG-RITE, as required by State law.

5. Construction Requirements

   a. Subdivisions

      1. Pre-Construction Conference. A pre-construction conference shall be held prior to beginning any construction. The developer or his representative shall schedule the

pre-construction conference by contacting the City of Battlefield.

The developer, engineer, and contractor, or their authorized representative(s) shall attend the conference.

2. Inspections. Periodic inspections will be made of the construction of stormwater improvements and facilities for sediment and erosion control throughout the construction period.

   Special inspections are required at the following times:

   a. After installation of initial sediment controls.

   b. Prior to paving.

   c. After placement of reinforcing steel and prior to placement of concrete for any reinforced concrete stormwater structure.

   d. After placement of riprap, before grout is applied.

3. Final Inspection and Acceptance of Improvements. After all storm drainage improvements are constructed, the consultant shall perform as-built surveys and prepare as-built drawings in accordance with the requirements of Section B. As-built drawings shall be submitted to the City of Battlefield.

   Upon receipt of the as-built drawings, the City of Battlefield will review the same for conformity with the plans and will conduct a field inspection of the completed storm drainage improvements.

   The developer will be notified in writing of any deficiencies discovered during review of the as-built drawings or field inspection.

   Upon correction of the noted deficiencies, the developer shall notify the City of Battlefield and schedule a field follow-up inspection. When all deficiencies have been corrected, the consultant shall submit one (1) set of as-built drawings and a

digital electronic copy of the same.

b. Grading & Building Permits

1. Pre-Construction Conference. A pre-construction conference may be required if warranted by the scope of construction.

2. Inspection. Inspection of sediment and erosion control measures and storm drainage facilities located on private property will be made by the City of Battlefield as set forth in Section A.4.a.2.

3. Final Inspection and Approval of Improvements. Final inspection and approval of storm drainage improvements shall be done as set forth in Section A.4.a.3.

For Building Permits, occupancy permits shall not be issued until as-built drawings are approved and construction of required storm drainage improvements is approved.

6. Ownership and Maintenance

a. Improvements on Public Road Right-of-Way

Storm drainage improvements on public right-of-way shall, upon acceptance of the improvements by the City of Battlefield, become the property of the City of Battlefield and shall be maintained by the City of Battlefield.

b. Improvements on Private Property

Storm drainage improvements on private property shall be maintained by the owner of the lot upon which the improvements are located, or by the subdivision Homeowners' Association for improvements located in common areas.

B. DRAWINGS AND CALCULATIONS

This section describes the requirements for drawings and calculations for storm drainage facilities which must be submitted and approved prior to filing of final plats for subdivisions, issuance of commercial building permits or issuance of grading permits.

Review and approval of drawings and calculations by the City of Battlefield is conceptual in nature only and does not imply detailed approval to any particular design item or data shown on the drawings, nor does it give implied approval for any variance from any City of Battlefield regulations or design standards. The design professional whose seal appears on the plans is responsible for all lines and grades, field data, and constructability of the design in compliance with the City of Battlefield standards and regulations.

1. Subdivisons

a. Professional Requirements

Construction drawings and calculations for subdivisions shall be prepared by an engineer registered to practice in the State of Missouri, having experience and training in the fundamentals of hydraulic engineering and storm drainage.

b. Submittal Requirements

Construction plans for storm drainage improvements required by the City of Battlefield Subdivision Regulations must be completed and approved by the City of Battlefield before the final plat can be filed or a grading permit can be issued for construction of the improvements. Construction plans must be submitted to the City of Battlefield. The following items must be submitted:

1. Six (6) sets of construction drawings, or the number currently specified in the Subdivision Regulations.

2. Two (2) copies of the Drainage Area Map.

3. Two (2) copies of computation sheets. Summary tables shown in Figures SS-B3 and SS-B4 may be used to summarize computations for storm drain piping and inlets. Other formats or computer program output summaries may be used provided they are clear and concise.

Incomplete submittals will be returned without review.

c. Construction Drawing Requirements

1. General. Construction drawings for streets and storm drainage improvements shall be submitted as a single set of construction drawings titled as follows:

Paving and Storm Drainage Improvements
for
(*Name of Subdivision*)
a Subdivision in the City of Battlefield, Missouri

Construction drawings shall be bound in a set of consecutively numbered sheets.

Each drawing must be signed by the City of Battlefield before the drawings are approved for construction.

Construction drawings shall clearly show the location and extent of proposed construction in relation to existing and proposed property lines, physical features, topography, and utilities, and shall include all details necessary to properly construct the proposed facilities. Linework and lettering shall be neat and clear. Original copies of the drawings shall be free from smudges, tears, folds, and other imperfections which affect the legibility of the drawing.

All construction drawings shall show the following:

- Title block, showing name of the proposed project, drawing title, and drawing number.
- Name, address, telephone and "fax" number of consultant.
- Seal of responsible design professional.
- A scale for each plan or detail.
- A north arrow for all full or partial site plans and maps.
- The Missouri One-Call utility locate symbol on all drawings involving earthwork.

2. Drawing Size. Unless otherwise approved in writing by the the City of Battlefield, original drawings shall be thirty-six inches (36") wide by twenty-four inches (24") high with a one-half inch (½") clear border on the top, bottom, and right sides of the drawing, and a one and one-half inch (1 ½") clear border on the left side of the drawing.

   Lettering shall be in a size large enough to allow reproduction of legible half-size drawings for use in the field.

3. Scale. Plans and details shall be drawn to definite,

conventional scales, unless specifically noted and approved otherwise. Scales shall be in English units. Required scales for various plans are set forth in Paragraphs 10. through 15., below.

4. Drafting Media. Construction drawings shall be drawn in ink on mylar.

5. Ownership and Possession of Drawings. Original drawings shall remain the property of the consultant.

6. Required Information. The following information must be included in the construction drawings:
   - General project information.
   - Site boundary and dimensions.
   - Grading plan.
   - Plan of proposed storm drainage facilities.
   - Sediment & Erosion Control Plan (SECP).
   - Profiles for storm drainage improvements.
   - Details of stormwater facilities.

   Specific information required for each item listed above is described in Paragraphs 10. through 15., below.

   It is not required that a separate drawing be prepared for each item listed above. The required information may be shown on the fewest number of drawings needed to present the information clearly and legibly, depending upon the size of the project and complexity of the proposed work.

7. Benchmarks and Vertical Datum. Datum shall be mean sea level (MSL) as defined by the National Geodetic Vertical Datum of 1927. Benchmark references shall be noted on the drawings. Two (2) City of Springfield benchmarks shall be referenced.

8. Horizontal Control. The site boundary shall be tied to the Missouri State Plane Coordinate System.

9. General Project Information. The following general information must be shown on the first sheet of the construction drawings:
   - Location map at a scale of 1" = 2000' (one inch equals

two thousand feet), showing streets and roads of collector or greater classification and municipal boundaries within one thousand feet (1000') of the site.
- General Notes, see Figure SS-B2.
- Name, address, telephone and fax number of developer.
- Index to drawings.
- Benchmark data.
- Legal description of property.
- Key to symbols used on the drawings.
- Location plan.

Where the proposed construction site consists of a phase of an approved preliminary plat, a location plan shall be shown on the first sheet, or the sheet immediately following the cover sheet of the drawings. The location plan shall show the entire area and boundary of the preliminary plat and the location and boundary of the proposed phase within the preliminary plat. Location plan scale shall not be smaller than 1" = 200' (one inch equals two hundred feet).

10. Site Boundary and Dimensions. The first or second drawing of the set must include a plan showing the site boundary and dimensions at a minimum scale of 1" = 100' (one inch equals one hundred feet), and the following information:
    - North arrow & graphic scale.
    - Site boundary with dimensions and bearings.
    - Proposed rights-of-way and lot lines with dimensions and bearings.
    - Property lines and owners' names for all properties adjoining the site (property lines for adjoining properties need only extend one inch (1") actual scale, outside the site boundary).
    - Location and dimensions of existing and proposed easements.
    - Street names.
    - Boundaries of cities and other political subdivisions.

11. Grading Plan. A grading plan for the entire site must be included in the drawings. The site boundary and dimension plan shall serve as the base for the grading plan. The grading plan shall show the following:
    - Existing topographic contours at two foot (2') maximum intervals. Each fifth contour shall be drawn

as an index contour by using a heavier line weight. Index contours must be labeled.

- Existing streets, transportation facilities, utilities, and storm drainage facilities.
- Existing physical features including waterbodies and watercourses, sinkholes, springs and caves.
- Existing structures, pavements, sidewalks, tree masses, pavements, and fences.
- Proposed streets, transportation facilities, utilities, and storm drainage facilities.
- Proposed structures, sidewalks, and pavements.
- Proposed topographic contours. The line type used for proposed contours must be heavier than that used for existing grades, and must have a different line type. Proposed contours shall be shown at two foot (2') maximum intervals. Each fifth contour shall be drawn as an index contour by using a heavier line weight. Index contours must be labeled.

12. Plan of Proposed Storm Drainage Facilities. An overall plan of the site showing all proposed storm drainage facilities shall be provided. The site boundary and dimension plan shall serve as the base for this plan. This plan may be superimposed upon the site grading plan, depending upon the size and complexity of the project, provided that clarity and legibility can be maintained. The plan of storm drainage facilities shall show the location of the following items:
    - Detention basins.
    - Sediment basins.
    - Storm drain piping.
    - Inlets.
    - Junction structures.
    - Open channels and swales.
    - Other components of the storm drainage system.
    - Horizontal location of all components of the storm drainage system, dimensioned to easements, right-of-way, or property lines. Where all components of the system cannot be legibly dimensioned at the scale of the overall plan, enlarged plans of these areas shall be provided.
    - Line numbers and structure reference numbers, as described below:

Beginning at each point of discharge from the site, the storm drainage system shall be organized into a system of "lines" for identification of profiles. Storm drainage lines shall be numbered in consecutive order, beginning with the number one (1). Inlets, outlets, junction structures, and other points of reference shall be designated by letters beginning at the downstream-most point in each line with the line number followed by the reference letter, beginning with the letter "A"; i.e., 1-A, 1-B, etc. Each line shall extend from the downstream point of discharge to the upstream-most element in the line, and shall include "non-constructed" elements, such as natural channels.

13. Sediment & Erosion Control Plan (SECP). An overall plan of the site showing proposed sediment and erosion control measures shall be included in the construction drawings. The sediment and erosion control plan shall be superimposed upon the site dimension plan, grading plan and storm drainage facilities plan. The sediment and erosion control plan shall also show the following:
    - General limits of the area to be stripped of vegetation or disturbed by construction activities shall be shaded or otherwise clearly delineated.
    - A summary table showing the total site area and the total area estimated to be disturbed.
    - Location of temporary construction entrance(s).
    - Proposed sediment containment measures: vegetative filter areas, straw bale dikes, silt fences, temporary containment berms, diversion berms, inlet protection, etc.
    - Site stabilization measures, showing the type of surface stabilization to be provided in various areas of the site, whether sod, erosion control blanket, mulch, riprap, concrete, etc. If more than one (1) type of erosion control blanket or mulch, is specified, the different areas should be distinguished by use of varying shading or symbols.
    - Seeding and mulching specifications, and allowable seasons for temporary and permanent seeding.
    - Temporary and permanent erosion control measures, such as outlet protection, channel linings, riprap or paved chutes, etc.
    - General notes for sediment & erosion control.

Recommended notes are shown in Figure SS-B5.

14. Profiles. Profiles for all storm drainage lines shall be included in the construction drawings. Profiles may be drawn at horizontal scales of 1" = 10' (one inch equals ten feet) to 1" = 50' (one inch equals fifty feet), depending upon the length of line to be shown, and vertical scales of 1" = 2' (one inch equals two feet) to 1" = 5' (one inch equals five feet). Profiles shall be stationed starting at the downstream end with Station 0+00. Profiles shall be drawn continuously from the downstream to the upstream end, with breaks only as needed when the profile exceeds the drawing width. Profiles shall not be combined with street profiles. Wherever breaks are made, equation stations and elevations shall be called out. Profiles shall include the following:

- Reference grid lines showing elevations along the left or right vertical margin and stationing along the bottom margin.
- Existing grade at centerline with a dashed line, labeled "Existing Grade at Centerline".
- Proposed grade at centerline with a solid line, labeled "Proposed Grade at Centerline".

  NOTE: Where the difference in grade between the centerline and the edge of the easement in which the proposed improvement is located is one foot (1') or more, additional existing grade and/or finish grade profile lines may also be required along the easement lines. Additional profile lines shall be labeled as to location.
- Existing and proposed utility crossings, labeled as to type: e.g. "Proposed 8" sanitary sewer", etc.
- Existing and proposed pavements, riprap, concrete linings, structures, foundations, or other features which would affect the grade of the proposed storm drain or channel. Both the top and bottom surface of pavements, foundations, etc. must be shown, in order that clearance is apparent. It is preferred that a shading or pattern be used.
- Profile of the proposed storm drain or channel invert, and the interior top of pipe or top of channel bank. For reinforced concrete pipe and reinforced concrete box culverts, the exterior top and bottom shall also be shown in the profile.

- The station and structure number shall be called out at each structure. Stations shall also be called out at each change of direction in the centerline, at points of horizontal curvature and tangency, and at changes in grade.
- The pipe or channel length in feet, and pipe or channel slope in percent.
- Invert elevations shall be called out for each structure, and at points of horizontal curvature and tangency. Incoming and outgoing invert elevations shall be shown.
- Incoming lines at structures and tees shall be shown and invert elevations called out.
- Where the vertical clearance is less than the minimum required in Section F or Section G, the actual clearance dimension shall be shown.
- Hydraulic grade line must be shown wherever storm drainage piping is under pressure flow conditions, and shall be labeled along with the return frequency of the storm for which the hydraulic grade line was calculated: e.g. “HGL25 for the 25-year storm”, etc.

15. Details. Enlarged plans and other details must be shown wherever necessary to clearly describe the location, dimensions, and grades for the proposed construction. Details shall be drawn in accordance with generally prevailing drafting standards. Details shall be drawn to conventional scales, unless noted as “Not to Scale”. Any scale distortions used for isometric or other views must be noted. Standard details included in these Design Standards may be referenced by note where available.

    The following details will typically be required:
    - Typical trench cross section for storm drain lines.
    - Typical cross sections for drainage channels, showing side slopes, design depth or water surface, freeboard, and type of lining.
    - Typical cross-sections of retaining walls.
    - Plan and sections for detention and sediment basin outlet structures.
    - Enlarged plans of inlets or junction structures, where incoming piping is thirty inches (30") or greater in diameter, or connection is made at other than 90

(ninety) degrees.

d. Calculations

Supporting calculations for storm drainage facilities must be included in the plan submittal. Supporting calculations shall include the following:

- Drainage area map meeting the requirements set forth in Paragraph 1 below.
- Summary table for inlet calculations (See Figure SS-B3 for example format).
- Summary table for storm sewer and channel design (See Figure SS-B4 for example format).
- Hydraulic data for drainage channels with uniform flow.
- Water surface profile computations for drainage channels with gradually or rapidly varied flow as set forth in Section G.3.
- Calculations for detention facilities as set forth in Section H.5.f.
- Calculations for sediment basins and other sediment and erosion control facilities specified on the Sediment & Erosion Control Plan, as set forth in Section I.
- Where required, calculations for directly connected impervious area, water quality capture volume, and stormwater quality best management practices (BMPs) as set forth in Section J.

1. Drainage Area Maps. Drainage area maps must be provided for both on-site areas and off-site areas. Due to the difference in area, it will typically be necessary to provide a larger scale map for on-site drainage areas, and a smaller scale map for off-site drainage areas.

   Off-site drainage areas shall be shown on 1976 Springfield Planning Area Maps, where these maps are available, at a minimum scale of 1" = 600' (one inch equals six hundred feet). Where these maps are not available, U.S.G.S. 7 ½ minute quadrangle maps shall be used, at a minimum scale of 1"= 2000' (one inch equals two thousand feet). Where more detailed or more current topographic maps are available, they must be used.

   On-site drainage area maps shall be shown superimposed upon the site plan, with existing and proposed topographic contours shown.

Drainage areas shall be clearly outlined on the map, and the identifying designation clearly shown. Drainage areas shall be given the same designation as the inlet or reference point to which they are tributary (i.e., drainage area 1-A is tributary to inlet 1-A).

The schematic plan of the proposed storm drainage improvements shall be shown on the drainage area map.

Both pre- and post-development drainage areas must be shown for each primary outfall from the site.

e. Revisions to Drawings

Prior to approval of the drawings by the City of Battlefield, drawings are considered preliminary and revisions shall not be noted. Revision notes made by the consultant for his own records prior to plan approval must be made outside the drawing border along the left margin of the drawing.

Any use of the construction drawings for bids or pricing which occurs prior to the plans being approved by the City of Battlefield, is solely at the risk of the developer.

Revisions made after the plans are signed must be noted in the revision block and must be replotted and signed by the City of Battlefield.

When revisions are made, two (2) copies of the revised drawing must be submitted to the City of Battlefield for review. After the revision is approved, two (2) copies of the revised drawing shall be provided to the City of Battlefield.

Revised areas must be clearly identified by clouding and noting with a symbol showing the revision number.

The final revision noted shall be the as-built drawings.

f. As-Built Surveys and Drawings

When construction of the improvements is completed, the Engineer shall perform surveys to determine that the location, dimension, and grade of the drainage improvements is in substantial conformance with the approved plans.

Location of improvements shall be checked by field survey to ensure that the improvements are completely located within the easements or rights-of-way which have been provided. The location of improvements which vary more than six inches (6") from the location shown on the approved plans, must be approved in writing by the City of Battlefield prior to approval.

Elevations and grades shall be verified at the following locations:

- Center of access manhole or grate for junction structures and inlets.
- Inlet entry for side opening inlets (except curb opening inlets).
- Pipe and culvert inverts. For box culverts greater than five feet (5') wide, invert elevation shall be checked at each side of the inlet and outlet.
- Detention basin and sediment basin outlet structures.
- Maximum intervals of one hundred feet (100') and at grade changes in drainage channels (excluding road side borrow ditches).
- Detention and sediment basins.

Elevations differing by more than one-tenth of a foot (0.1') from plan grades or five-hundredths of a foot (0.05') for detention basin outlet structures, must be approved in writing by the City of Battlefield prior to final approval.

Dimensions must be verified for the following:

- Pipe diameter for circular pipe.
- Height and width for elliptical or arch pipe, or box culverts.
- Drainage channel cross-sections at maximum intervals of two hundred feet (200').
- Riprap or other erosion protection at pipe outlets.
- Overflow spillways and outlet structures for detention and sediment basins.
- Detention and sediment basin volume.

As-built information shall be shown on the approved plans in the same manner that revisions are noted on the drawings. As-built information shall be clouded and noted with a symbol showing the revision number. Where the as-built dimension or elevation does not differ from the plan, the plan dimension or elevation shall be clouded to signify that it has been verified.

2. Commercial Building Permits

a. Professional Qualifications

Construction drawings and calculations for storm drainage facilities and grading, sediment and erosion control plans associated with commercial buildings must be prepared by an engineer registered to practice in the State of Missouri, having training and experience in the fundamentals of hydraulic engineering and storm drainage.

b. Submittal Requirements

Construction plans for storm drainage improvements must be completed and approved by the Stormwater Engineer before the building permit can be issued.

Storm drainage drawings and calculations shall be submitted to the Building Regulations Department along with the building plans. The following items must be submitted:

1. Two (2) sets of construction drawings.
2. Two (2) copies of the Drainage Area Map.
3. Two (2) copies of computation sheets.

Incomplete submittals will be returned without review.

c. Construction Drawing Requirements for Commercial Building Permits

1. General. Construction drawings for storm drainage improvements may be submitted as a separate set of construction drawings or included in the building plans.

Construction drawings shall clearly show the location and extent of proposed construction in relation to existing and proposed property lines, physical features, topography, and utilities, and shall include all details necessary to properly construct the proposed facilities. Linework and lettering shall be neat and clear. Original copies of the drawings shall be free from smudges, tears, folds, and other imperfections which affect the legibility of the drawing.

All construction drawings shall show the following:

, Title block, showing name of the proposed project, drawing title, and drawing number.

, Name, address, telephone and “fax” number of consultant.
, Seal of responsible design professional.
, A scale for each plan or detail.
, A north arrow for all full or partial site plans and maps.
, The Missouri One-Call utility locate symbol on all drawings showing plans or details involving earthwork.
, A block for approval signature by the City of Battlefield, located in the lower right area of each drawing.

2. Drawing Size - Commercial Building Permits. Original drawings may range in size from twenty-four inches wide by eighteen inches high (24" x 18") to forty-two inches wide by thirty-six inches high (42" x 36"). Drawings shall have a one-half inch (½") clear border on the top, bottom and right sides of the drawing, and a one and one-half inch (1 ½") clear border on the left side of the drawing.

   Lettering shall be of a large enough size to allow reproduction of legible half-size drawings for use in the field.

3. Scale - Commercial Building Permits. Plans and details shall be drawn to definite, conventional scales, unless specifically noted and approved otherwise. Scales shall be in English units.

4. Drafting Media - Commercial Building Permits. Construction drawings shall be drawn in ink or pencil, on vellum, mylar, paper or other suitable drafting medium from which clear copies can be reproduced.

5. Required Information - Commercial Building Permits. The following information must be included in the construction drawings:
   , General project information.
   , Site boundary and dimensions.
   , Grading plan.
   , Plan of proposed storm drainage facilities.
   , Sediment & Erosion Control Plan (SECP).
   , Profiles for storm drainage improvements.
   , Details of stormwater facilities.

   It is not required that a separate drawing be prepared for each

item listed above. The required information may be shown on the fewest number of drawings needed required to present the information clearly and legibly, depending upon the size of the project and complexity of the proposed work.

6. Benchmarks and Vertical Datum - Commercial Building Permits. It is preferred that mean sea level (MSL) as defined by the National Geodetic Vertical Datum of 1927 be used as datum for elevation information on the drawings. For sites within the Springfield Urban Services Area, it is preferred that City of Springfield benchmarks shall be referenced. For sites outside this area, it is preferred that U.S.G.S. benchmarks be referenced. Assumed datum may be used provided that it is based upon assumed elevation of 100.0 (one hundred point zero), so as not to be confused with actual elevations from mean sea level. Benchmark references shall be noted on the drawings.

7. General Project Information - Commercial Building Permits. The following general information must be shown on the first sheet of the construction drawings:
   - Location map at a scale of 1" = 2000' (one inch equals two thousand feet), showing streets and roads of collector or greater classification and municipal boundaries, within one thousand feet (1000') of the site.
   - General notes.
   - Name, address, telephone and “fax” number of owner or developer.
   - Index to drawings.
   - Benchmark data.
   - Legal description of property.
   - Key to symbols used on the drawings.

8. Site Plan - Commercial Building Permits. The drawings must include a plan showing the site boundary and dimensions, and existing and proposed utilities and improvements at a minimum scale of 1" = 100' (one inch equals one hundred feet), including the following information:
   - North arrow & graphic scale.
   - Site boundary with dimensions and bearings.
   - Rights-of-way and names of streets adjoining the site.
   - Property lines and owners’ names for all properties adjoining the site (property lines for adjoining

properties need only extend one inch (1"), actual scale, outside the site boundary).

- , Location and dimensions of existing and proposed easements.
- , Boundaries of cities and other political subdivisions.
- , Existing transportation facilities, utilities, and storm drainage facilities.
- , Existing physical features including waterbodies and watercourses, sinkholes, springs and caves.
- , Existing structures, pavements, sidewalks, tree masses, pavements, and fences
- , Proposed transportation facilities, utilities, and storm drainage facilities.
- , Proposed buildings, incidental structures, structures such as retaining walls, sidewalks, pavements and other proposed improvements.

9. Grading Plan - Commercial Building Permits. A grading plan for the entire site must be included in the drawings. The site plan shall serve as the base for the grading plan. The grading plan shall show the following:

- , Existing topographic contours at two foot (2') maximum intervals. Each fifth contour shall be drawn as an index contour by using a heavier line weight. Index contours must be labeled.
- , Proposed topographic contours. The line type used for proposed contours must be heavier than that used for existing grades, and must have a different line type. Proposed contours shall be shown at two foot (2') maximum intervals. Each fifth contour shall be drawn as an index contour by using a heavier light weight. Index contours must be labeled.

d. Calculations - Commercial Building Permits.

Requirements for calculations and drainage area map are set forth in Section B.1.d.

e. Revisions to Drawings for Commercial Building Permits.

Revisions made after the plans are signed must be noted in the a revision block and must be initialed by the City of Battlefield prior to

approval.

When revisions are made, two (2) copies of the revised drawing must be submitted to the City of Battlefield for review. After the revision is approved, two (2) copies of the revised drawing shall be provided to the City of Battlefield.

Revised areas must be clearly identified by clouding and noting with a symbol showing the revision number.

The final revision noted shall be the as-built drawings.

f. As-Built Surveys and Drawings for Commercial Building Permits

When construction of the improvements is completed, the Engineer shall perform surveys to determine that the location, dimension, and grade of the drainage improvements is in substantial conformance with the approved plans.

Location of improvements shall be checked by field survey to ensure that the improvements are completely located within the easements or rights-of-way which have been provided. The location of improvements which vary more than six inches (6") from the location shown on the approved plans must be approved in writing by the City of Battlefield prior to approval.

Elevations and grades, and location and dimensions of improvements shall be verified and shown on as-built drawings as set forth in Section B.1.f. As-built surveys must be approved prior to the final approval of the building and issuance of a temporary or permanent occupancy permit.

3. Commercial Grading Permits

a. Professional Requirements

Professional qualifications required for preparation of drawings and calculations for grading, sediment and erosion control plans are set forth in Section I.3.c.

b. Submittal Requirements

For sites upon which only grading and construction of utilities and/or

drainage improvements are proposed, construction drawings shall meet the requirements set forth in Section B.2. Drawings and calculations shall be submitted to the City of Battlefield. The following items must be submitted:

, Two (2) sets of construction drawings.
, Two (2) copies of the Drainage Area Map.
, Two (2) copies of computation sheets.

C. STORMWATER RUNOFF COMPUTATIONS

1. General. This policy describes methods which can be used to determine rates and volumes of stormwater runoff. It is important to remember that the physical relationship between precipitation and the rate and amount of runoff is very complex, and that computational methods which have been developed are empirical. When applying any hydrologic technique, the designer must be aware of its basic assumptions and limitations. Experience and good judgement must be used to evaluate the results.

a. Key Terms

The following key terms should be used in describing runoff computations:

Pre-project conditions - the topography, surface cover, and other hydrologic conditions in the watershed being considered as they exist prior to the proposed development.

Post-project conditions - the topography, surface cover, and other hydrologic conditions in the watershed as they will be after construction of the proposed development.

Fully urbanized conditions - the topography, surface cover, and other hydrologic conditions in the watershed as they will be after all areas in the watershed have been developed in accordance with current zoning designations, as provided in the Greene County Comprehensive Plan, or as can otherwise be reasonably anticipated.

2. Precipitation Data. Precipitation data used for computing runoff rates and volumes for use in the design of stormwater management facilities in the City of Battlefield are derived from data published by Greene County. These data are summarized in Tables SS-C1 and SS-C2, and Figures SS-C1, SS-C2 and

SS-C3.

3. Topographic Data. Topographic data utilized in determining drainage areas must be sufficiently detailed to allow computation of runoff with a reasonable degree of accuracy.

   a. On-site Drainage Areas

      Topographic maps with a maximum contour interval of not more than two feet must be utilized for determining drainage areas within the development site. Topographic maps must show existing and proposed drainage facilities such as storm drains, culverts, road cuts, ditches and other physical features which affect the patterns of runoff on the site.

   b. Off-site Drainage Areas

      Maps published by the U.S. Geological Survey having a maximum contour interval of ten feet (10') will generally be considered sufficiently accurate for use in determining drainage areas where no development has occurred. For small drainage areas where U.S.G.S. maps do not have a sufficient level of accuracy or where drainage patterns have been altered by development, the best available data should be used.

      NOTE: Topographic information (five foot (5') contour intervals) is available for certain portions of the area around the City of Springfield on the 1976 Springfield Planning Area maps. These maps should be used in determining off-site drainage areas, where more detailed maps are not available. Where no other topographic maps having sufficient detail to determine the drainage area in question are available, aerial photo maps available from the County Assessor's office should be used with drainage area limits and paths of flow determined in the field.

      Regardless of the data used, it is the designer's responsibility to field verify that the drainage areas used are reasonably accurate.

4. Methods for Computing Runoff

   a. Peak Runoff Rates

      1. Drainage areas less than 200 acres. Where the tributary drainage area is less than two hundred (200) acres, and only the

peak runoff rate is needed, the peak runoff rate may be computed by the Rational Method as described below. Peak flow rates for designing inlets and conveyance facilities (storm drains and open channels) for most developments can be computed by this method.

2. Urban drainage areas equal to or greater than 200 acres. Where the tributary drainage area is two hundred (200) acres or more, and only the peak flow rate is needed, the peak runoff rate shall be computed by any of the following methods:

   a) Soil Conservation Service TR-55, Graphical Peak Discharge Method. Hydrologic soil groups for soils listed in the Greene County soil survey are shown in Table SS-C4.

   b) Unit hydrograph methods.

3. Rural drainage areas equal to or greater than 200 acres. Peak runoff rates for rural watersheds equal to or greater than two hundred (200) acres shall be computed by any of the following methods:

   a) Soil Conservation Service TR-55 Graphical Peak Discharge Method.

   NOTE: This method is limited to a maximum time of concentration of ten (10) hours.

   b) U.S. Geological Survey Technique for Estimating the 2- to 500-year Flood Discharges on Unregulated Streams in Rural Missouri.

   c) Unit hydrograph methods (See Section C.4.c).

b. Runoff Volumes

   Runoff volumes shall be computed using Soil Conservation Service TR-55, or any of the unit hydrograph methods listed below.

c. Hydrograph Methods

   When runoff rates must be known as a function of time, such as for reservoir routing computations or when the limitations of the methods

listed above are exceeded, hydrograph methods must be used. Commonly accepted hydrograph methods are as follows:

U.S. Army Corps of Engineers HEC-1 Flood Hydrograph Package.

Soil Conservation Service TR-55 and TR-20.

USEPA Storm Water Management Model (SWMM).

Other methods may be used upon written approval of the City of Battlefield, provided that they are documented in accepted engineering literature and are used within the limitations stated.

Methods used for distribution of rainfall, determining precipitation losses, accounting for channel and reservoir storage effects, etc., shall be as prescribed in the literature for the selected method.

Where the method gives the designer the choice of precipitation distribution, use of the Pilgrim-Cordery distribution is preferred. Synthetic rainfall mass curve data for this distribution is shown in Table SS-C5.

d. Accuracy

Runoff computations are based upon empirical methods and cannot be expected to give precise results. Results should always be rounded off or shown with a limited number of significant digits to avoid implying an accuracy greater than that which can be expected. Runoff rates and volumes should be rounded up to the nearest ten percent (10%) of the computed value.

5. Rational Method. The rational formula may be used to compute peak runoff rates only for drainage areas less than two hundred (200) acres. The rational method or variations of the rational method are not reliable for use in determining runoff volumes.

The formula for the rational method is as follows:

Q = C I A, where

Q = peak runoff rate for a design storm of recurrence interval, T, in cubic feet per second (cfs);

C = dimensionless runoff coefficient; recommended runoff coefficient values are given in Table SS-C3. The value used shall be the composite value based upon the type of surface coverage in the drainage area for the runoff condition being considered.

I = average rainfall intensity for a storm of recurrence interval, T, over a duration equal to or greater than the time of concentration for the contributing drainage area.

The time of concentration utilized shall be determined for conditions under which the peak flow rate is calculated; i.e. pre-project conditions for the pre-project peak flow rate and post-project conditions for the post-project peak flow rate, etc.

A = tributary watershed area in acres

NOTE: 1 acre-inch per hour = 1.008 cfs; therefore, the unit conversion factor is typically ignored.

6. Time of Concentration. The time of concentration is defined as the travel time from the hydraulically most distant point in the contributing drainage area to the point under study, or, the rainfall intensity averaging time. Time of

concentration for use with the Rational Method may be computed by either of the two methods described below. The minimum time of concentration which shall be used is five (5) minutes.

The Soil Conservation Service Method, or other methods for which there is documentation in commonly accepted literature, shall be used in computing peak runoff rates for other methods.

a. Kirpich Formula

$$t_c = 0.0078\left[\frac{L}{\sqrt{S}}\right]^{0.77}$$

t_c = time of concentration in minutes
L = length of travel in feet
S = slope of the flow path from the remote part of the basin to the calculation point divided by the horizontal distance between the two points (ft./ft.)

b. Soil Conservation Service Method

The method given in Chapter 3 of Soil Conservation Service TR-55 may be used to compute times of concentration. In using this method it must be remembered that overland flow elements are limited to three hundred feet (300') in rural areas, and generally to one hundred feet (100') in urban areas. The designer must consider whether calculated runoff rate from directly connected impervious areas having a shorter time of concentration will exceed the runoff rate for the entire drainage area when pervious areas are included.

D. SINKHOLES AND KARST FEATURES

1. General. The City of Battlefield is located on the Springfield Plateau of the Ozarks physiographic region. This area is underlain by Mississippian Age limestone which is highly susceptible to solutional weathering. As a result, sinkholes, springs and caves are common.

In many areas of City of Battlefield, special consideration must be given to flood hazards and potential for groundwater contamination due to the presence of sinkholes, caves, losing streams, springs, and other features associated with karst geology.

The requirements set forth herein are intended to provide specific criteria for

design and construction for any site upon which sinkholes or other karst features are located.

2. Policy. This policy is set forth for development in areas containing sinkholes. Development in sinkhole areas will be based upon the following approach:

a. Avoidance
b. Minimization
c. Mitigation

Construction in sinkholes shall be avoided. Exceptions will be made only in situations where it can be conclusively demonstrated that there are no practical alternatives to such construction.

In these cases, measures which will have minimal impact on the sinkhole or receiving water may be proposed. Plans for minimal alteration can be approved provided it is conclusively demonstrated that the proposed plan is the minimum practical alternative.

Potential impacts of construction on the sinkhole and receiving waters must be studied and assessed, and recommendations made for mitigation of potential impacts upon flooding, structural stability, and groundwater quality before the development plan can be approved. The degree and sophistication of study required will increase in proportion to the potential impacts.

3. Definitions

a. Sinkhole: Any depression in the surface of the ground, with or without collapse of adjacent rock, that provides a means through which surface water can come into contact with subsurface water.

Sinkhole depressions may be gradual or abrupt; they may or may not have a well defined eye. While most sinkholes can be defined as the area within a "closed contour", some sinkholes, such as as those located on the sides of hills and in stream valleys, may not. All sinkholes provide discreet points of recharge to groundwater.

b. Sinkhole Watershed: The ground surface area that provides drainage to the sinkhole. This area extends beyond the sinkhole depression and generally crosses property boundaries.

c. Virgin Sinkhole: A sinkhole which has never been altered or disturbed.

d. Altered Sinkhole: A sinkhole which has been filled, excavated or otherwise disturbed.

e. Collapsed Sinkhole: A subsidence or cave-in of the ground surface caused when soil overburden can no longer be supported by underlying strata due to the presence of subsurface solution cavities.

f. Sinkhole Eye: Generally, a visible opening, cavity or cave in the bottom of a sinkhole, sometimes referred to as a swallow hole.

g. Sinkhole Rim: The perimeter of the sinkhole depression. The sinkhole rim will generally vary in elevation.

h. Sinkhole Cluster Area: An area containing two (2) or more sinkholes located in close proximity, generally interconnected by groundwater conduits.

i. Terminal Sinkhole: The lowest sinkhole in a sinkhole cluster to which any surface water overflowing from other sinkholes in the cluster will flow.

j. Sinkhole Flooding Area: The area inundated by runoff from a storm with an annual exceedance probability of one percent (1%) and a duration of twenty-four (24) hours (eight inches (8") in Greene County).

k. Qualified Geologist: A person registered to practice geology according to the laws of the State of Missouri, and who by reason of technical education and experience has a background in the fundamentals of storm drainage and karst geology.

l. Qualified Professional Engineer: A person registered to practice engineering according to the laws of the State of Missouri, and who by reason of technical education and experience has a background in the fundamentals of storm drainage and karst geology.

m. Heavy Equipment: Motorized equipment having a gross weight of more than six (6) tons.

n. Light Equipment: Motorized equipment weighing six (6) tons or less.

4. Permits Required

a. Grading Permit

A grading permit must be obtained prior to any alteration of sinkholes. Grading permit requirements are set forth in Section I.3 of these Design Standards.

b. Other Permits

Other County, State or Federal may be required as outlined in Section A of these Design Standards, depending upon the size and nature of the proposed activity.

5. General Plan Requirements. Sinkholes and karst features shall be shown on sketch plans, preliminary and final plats.

General requirements for grading and drainage plans are set forth on Sections B and I of these Design Standards.

6. Sinkhole Evaluation Report. A written evaluation including the following information shall be made for all development sites upon which sinkholes are fully or partially located. The sinkhole evaluation report must include the following items:

a. Site Plan

The site plan shall meet the requirements of Section B. In addition, the site plan must show the following items with respect to location of proposed construction, proposed or existing property lines, and existing structures:

1. Sinkholes

a) Location and limits of the area of the sinkhole depression as determined by field surveys or other reliable and accurate methods.

Location of sinkholes based solely upon USGS 7-1/2 Minute Series Quadrangle Maps will not be considered sufficient unless field verified.

b) Location and elevation of the sinkhole eye or low point.

c) Topographic contours at maximum intervals of two feet

(2'), and spot elevations sufficient to determine the low point on the sinkhole rim and the profile of the potential overflow area.

Larger contour intervals may be used if deemed sufficiently accurate to define the sinkhole rim and volume.

d) Minimum elevation at which floodwaters can gain entry to any existing structures located within or on the sinkhole rim.

e) Elevation of any roadway located within or adjacent to the sinkhole.

2. Other Geologic Features. Location of caves, springs, faults, fracture trends, and geologic mapping units, based upon information from the Greene County Resource Management Department or other reliable sources.

3. Sinkhole flooding area determined as set forth in Section D.7.

4. Existing watercourses, storm sewers or culverts which drain into the sinkhole.

5. Proposed discharge points: The location type and size of all points at which concentrated discharges of stormwater into the sinkhole are proposed. The drainage area to each point of concentrated discharge shall be delineated on the plan and the size of drainage area noted.

6. Existing and proposed wells or other water supply sources.

b. Area Map

An area map showing the sinkhole watershed area must be provided. Where the site is located in a sinkhole cluster area, the map area shall be extended to include in the watershed area any sinkholes located downstream of the site which may receive overflow drainage from the site. Requirements for drainage area maps are set forth in Section C.

The approximate location of public or private water supply sources such as springs or wells within five hundred feet (500') of the site, and

boundaries of any known recharge areas to wells, springs, or caves as determined from information available from the Greene County Resource Management Department, Watershed Committee of the Ozarks, Missouri Department of Natural Resources, Missouri Department of Conservation, or other reliable sources shall be shown.

7. Flooding Evaluation. Maximum estimated flooding elevations shall be determined for each sinkhole for both pre-project and post-project conditions, assuming no subsurface outflow from the sinkhole.

a. Runoff Volume

The volume of runoff considered shall be that which results from a rainstorm with an annual exceedance probability (AEP) of one percent (1%) (100-year storm) and a duration of twenty-four (24) hours (eight inches (8") for Greene County). The runoff volume shall be determined by the method set forth in Chapter 2 of the SCS TR-55 Manual.

b. Sinkhole Flooding Area

For sinkholes whose tributary drainage area is small enough that it is unlikely the entire sinkhole would flood, the sinkhole flooding area can be conservatively estimated as the area below the low point on the sinkhole rim without further analysis.

Where the estimated volume of runoff exceeds the volume of the sinkhole depression, the depth of overflow shall be estimated and the sinkhole flooding area can be estimated as the area below the maximum flooding elevation. Where the volume of the sinkhole is sufficiently large that storage in the sinkhole depression will materially affect estimated outflow rates, reservoir routing can be performed, if desired, to determine the maximum flood stage in the sinkhole.

In sinkhole cluster areas, the overflow volume shall be included in determining the maximum estimated flooding elevations in the next downstream sinkhole. This analysis shall continue downstream until the lowest sinkhole of the sinkhole cluster is reached or overflow reaches a surface watercourse.

c. Flooding Considerations

No further flooding analysis will be required provided that the post-project flooding area of any sinkhole which receives drainage from the site is located entirely on the development site.

Where the post-project sinkhole flooding area is not entirely located on the development site, a detailed flooding analysis as set forth in Section D.7.d will be required, unless:

1) the post-project flooding elevation is no more than one foot (1') higher than the pre-project flooding elevation and the minimum elevation at which floodwaters can gain entry to any existing structures is at least one foot (1') higher than the post-project flooding elevation. Where several properties drain to the sinkhole, the amount of increase allowed will be proportioned on the basis of the area of the development site versus the area of the watershed tributary to the sinkhole; and the increase in volume of runoff from the site does not cause the flooding depth on any existing public road to exceed the maximum depths set forth in Section E; or,

2) the minimum elevation at which floodwaters can gain entry to any existing structures is at least one foot (1') higher than the post-project flooding elevation and a drainage easement covering the post-project flooding area is provided for any off-site sinkhole or portion of a sinkhole which receives increased peak rates of runoff from the site. If the receiving sinkhole is not contiguous to the site, an easement must also be provided for the waterway which connects the site to the sinkhole; and the increase in volume of runoff from the site does not cause the flooding depth on any existing public road to exceed the maximum depths set forth in Section E.

d. Detailed Flooding Analysis

In cases where the conditions set forth in Section D.7.c cannot be met, detention basins must be constructed outside of the sinkhole flooding area. The detention facility must have sufficient volume to store the increase in total runoff volume due to the development. Outflow rates cannot exceed pre-project values. Detention basins must be designed as set forth in Section H.

e. Diversion to Surface Watercourse

As an alternative, where feasible, increased post-project runoff may be diverted to a surface watercourse, provided that

1) any increase in peak runoff rate in the receiving watercourse does not create or worsen existing flooding problems downstream; and

2) the diverted stormwater remains in the same surface watershed.

Storm sewers, open channels, and other appurtenances provided for diversions shall be designed in accordance with applicable sections of these Design Standards.

The effect of diverted water on downstream watercourses and developments, and requirements for additional detention facilities prior to release of runoff to the surface watercourses shall be determined as set forth in Section H.

Effects of the diversion shall be shown by reservoir routing analysis. Routing of excess runoff shall be considered satisfactory when it can be demonstrated that the post-project flooding elevation in the sinkhole is at least one foot (1') below the minimum elevation at which floodwaters can gain entry to any existing structures and does not exceed the pre-project flooding elevation by more than one foot (1') in any case.

8. Water Quality Considerations. Sinkholes provide direct recharge routes to groundwater. As a result, water quality in wells, caves, and springs may be affected by discharge of runoff from developed areas.

The Sinkhole Evaluation Report must consider potential impacts of the proposed construction on receiving groundwaters as well as the possible impacts of sediment from construction sites on the sinkhole and propose measures to mitigate such impacts.

With regard to groundwater quality, three (3) factors must be considered:

Receiving groundwater use.
Relative groundwater contamination hazard associated with the proposed development.

Water quality management measures to reduce pollutant levels.

a. Receiving Groundwater Use

The Sinkhole Evaluation Report shall identify whether the site lies within a critical area based upon information available from the Greene County Resource Management Department or other reliable sources.

Where disagreements may arise over whether a site is located within a particular recharge area, dye tracing may be required for confirmation of the destination of water discharged through the sinkhole.

1. Critical Areas**.** The following areas are classified as critically sensitive to contamination from urban runoff:

    a. Areas with one hundred feet (100') of private water supply wells.

    b. Areas with three hundred feet (300') of public water supply wells.

    c. Areas within five hundred feet (500') of springs used for public or private water supply.

    d. Areas within one thousand feet (1000') of caves providing habitat to rare or endangered species such as the Ozark cavefish.

    The distances listed above may be extended in any instance where the recharge area for a well, spring, or cave has been determined by studies by a qualified engineer or geologist.

2. Sensitive Areas**.** All other sinkhole areas will be classified as sensitive for groundwater contamination.

b. Groundwater Contamination Hazard

The relative potential for groundwater contamination will be classified as moderate, high or very high, depending upon the type of land use, development density, and amount of directly connected impervious area.

1. Moderate Hazard**.** The following land uses are classified as posing a moderate hazard for groundwater contamination:

a. Residential developments on sewer, provided directly connected impervious areas discharging to the sinkhole is less than one (1) acre.

b. Parks and recreation areas.

c. Low density commercial and office developments provided directly connected impervious areas discharging to the sinkhole is less than one (1) acre.

d. Discharge from land disturbance areas less than one (1) acre.

2. High Hazard**.** The following land uses are classified as posing a high hazard for groundwater contamination:

a. Concentrated discharge from streets, parking lots, roofs and other directly connected impervious areas having an area greater than one (1) acre and less than five (5) acres.

b. Multifamily residential developments and higher intensity office developments provided the directly connected impervious areas discharging to the sinkhole is less than five (5) acres.

c. Discharge from land disturbance areas greater than one (1) acre and less than five (5) acres.

3. Very High Hazard**.** The following land uses are classified as posing a very high hazard for groundwater contamination:

a. Collector streets in industrial and manufacturing zones, all arterial streets and highways.

b. Railroads.

c. Concentrated discharge from streets, parking lots, roofs and other directly connected impervious areas having an area greater than five (5) acres.

d. Commercial, industrial and manufacturing areas in

Zoning Districts C-2, M-1 and M-2.

e. Individual wastewater treatment systems.

f. Commercial feedlots or poultry operations.

g. Discharge from graded areas greater than five (5) acres.

c. Water Quality Management Measures

The majority of sinkholes drain a limited watershed area. For sinkholes where the surrounding drainage area is small enough that the area draining to the sinkhole flows predominantly as "sheet flow", potential impacts on water quality can be addressed in many cases by erecting and maintaining reliable silt control barriers around the sinkhole during construction and providing a vegetative buffer area around the sinkhole to filter out potential contaminants.

Where inflow is concentrated, the degree of effort required to capture and filter out contaminants increases significantly.

Concentrated inflow occurs naturally when the sinkhole watershed area reaches a sufficient size for watercourses leading into the sinkhole to form. Concentrated surface flows result as urbanization occurs due to construction of roads, storm sewers, and drainage channels. Subsurface flows can become concentrated through utility trenches.

Required water quality management measures are as set forth below:

1. Management Measures for Moderate Hazard Areas.

a. Sediment and erosion control

Existing ground cover shall not be removed within twenty-five feet (25') of the sinkhole flooding area and a silt barrier shall be erected and maintained around the outer perimeter of the buffer area. Vegetative cover must be of sufficient quality and density to provide desired filtration.

A ditch check(s) meeting the requirements set forth in Section I.6.c.5 will be required at each point where concentrated flow is discharged into the sinkhole.

b. Permanent Management Measures

Where flow into the sinkhole occurs as sheet flow, water quality requirements can be satisfied by maintaining a permanent vegetative buffer area with a minimum width of twenty-five feet (25') around the sinkhole flooding area.

Concentrated flows may be discharged into the sinkhole through grassed swales and channels designed for non-erosive velocities. Temporary erosion control measures such as sodding or erosion control blankets shall be provided.

2. Management Measures for High Hazard Areas

a. Sediment & Erosion Control

A sediment basin will be required at each point where concentrated flows are discharged into the sinkhole. Sediment basins shall be designed according to the procedures set forth in Section I.

b. Permanent Management Measures

Extended wet or dry detention basins designed as set forth in Section J shall be provided at all points of concentrated discharge. Other Best Management Measures may be specified provided that their performance is equal to that of extended detention basins.

3. Management Measures for Very High Hazard Areas

a. Sediment & Erosion Control

A sediment basin will be required at each point where concentrated flows are discharged into the sinkhole. Sediment basins shall be designed according to the procedures set forth in Section I. Specific limits may be placed on the area which can be graded at any one time and on the length of time allowed from initial

disturbance to stabilization.

b. Permanent Management Measures

Runoff from all areas must pass through extended wet or dry detention basins designed as set forth in Section J. Other Best Management Measures may be specified provided that their performance is equal to that of extended detention basins.

9. Development Requirements

a. Stormwater Detention in Sinkholes

Where flooding considerations set forth in Section D.7.a and water quality considerations as set forth in Section D.8 can be met, the volume of runoff storage in sinkholes can be counted toward stormwater detention requirements. The volume of required detention storage shall be determined as set forth in Section H.

Excavation within the sinkhole flooding area to provide additional detention storage will not be allowed.

b. Modification of Sinkholes to Increase Outflow Rates

Increasing outflow rates in sinkholes by excavating the sinkhole eye or installing disposal wells for diverting surface runoff to the groundwater system is prohibited, unless clear and imminent danger to public health and safety can be demonstrated.

c. Setbacks and Use Restrictions

The following setbacks and use restrictions are established:

1. No new construction of any of the following shall be permitted within twenty-five feet (25') of the sinkhole rim, unless special measures are approved to address structural and water quality concerns:

a. Commercial or industrial structures.

b. Streets, highways, or parking lots.

c. Storage yards for materials, vehicles, and equipment.

d. Sanitary sewer lines.

2. New construction of any of the following may be permitted within the sinkhole rim provided that they are set back a minimum of twenty feet (20') of the sinkhole flooding area:

   a. Residential structures, provided the lowest floor elevation is set a minimum of five (5) feet above the sinkhole flooding elevation, or one foot (1') above the lowest elevation on the sinkhole rim, whichever is less, and provided that a statement of a qualified engineer is submitted indicating that foundation conditions are suitable for residential structures.

   b. Swimming pools.

   c. Underground utilities other than sanitary sewer, if provisions are made to prevent migration of groundwater along the trench.

3. Use of pesticides and fertilizers within twenty-five feet (25') of the sinkhole rim is prohibited, unless such usage is in accordance with a management plan approved by the City of Battlefield.

4. Use of heavy construction equipment in virgin sinkholes is prohibited.

5. Recreational facilities such as hiking, jogging, and bicycling trails, playgrounds, exercise courses, and grass playing fields are permitted within the sinkhole flooding area provided they are not located within the eye of the sinkhole.

6. Clearing and pruning of trees and undergrowth, and limited grubbing of roots is permitted.

7. Landscaping and minor gardening is permitted outside of the sinkhole eye provided erosion and sediment discharge is limited through use of minimum tillage and mulches.

8. Construction of light incidental landscaping and recreational

structures such as playground equipment, etc., is permitted except in the sinkhole eye.

9. Facilities which involve storage or handling of hazardous or toxic materials shall not be permitted in sinkhole watershed areas.

d. Collapsed Sinkholes

Collapsed sinkholes may be stabilized and filled using approved techniques as shown in Figure D.1 provided a sinkhole evaluation has been completed by a qualified geologist or engineer. A Grading Permit must be issued prior to performing any construction.

The probable cause of the collapse and potential adverse impacts of filling the collapse shall be investigated and information submitted with the Grading Permit application.

10. Springs & Caves

a. Springs

No new construction will be permitted within one hundred feet (100') of a spring unless a report, prepared by a qualified engineer or geologist verifying that the quantity and quality of the spring flow will not be materially altered by the proposed construction, is submitted and approved by the City of Battlefield.

b. Caves

No new construction will be permitted within one hundred feet (100') of the known alignment of a cave unless a report, prepared by a qualified engineer or geologist verifying that the cave will not be materially altered by the proposed construction and that sound foundations or other support for the proposed construction will not be subject to collapse or undue settling, is submitted and approved by the City of Battlefield.

1. Security. The entrances of caves shall be protected against unauthorized entry, while allowing for the unimpeded flow of groundwater and without disruption to habitat for cave-dwelling animal species. Plans for cave entrance protection must be approved by the City of Battlefield prior to

construction.

E. INLETS

1. Inlet Locations. Inlets shall be provided at locations and intervals, and shall have a minimum inflow capacity such that maximum flooding depths set forth in Figure SS-E1 are not exceeded for the major or minor storm, Inlets shall be provided at all sump locations to prevent ponding of water. **It is recommended that inlets be provided at street intersections upstream of pedestrian cross-walks.**

2. Inlet Interception Capacities. Inlet capacities shall be determined in accordance with Federal Highway Administration HEC-12 or HEC-22. The gutter slope to be used for design of curb opening inlets located on vertical curves shall be the average gutter slope for a distance of twenty feet (20') upstream of the inlet. Variables for use in standard curb opening inlet computations are defined in Figures SS-E3 and SS-E4.

   Figures SS-E5 and SS-E6 show capacity charts for standard type SS-5 and SS-6 curb opening inlets on grades and in sumps.

   Nomographs and methods presented in the Neenah Inlet Grate Capacities report may also be used where applicable.

   The use of commercial software utilizing the methods of HEC-12 or HEC-22 is acceptable.

a. Clogging Factors

The inlet capacities determined as required in this section should be reduced as follows, in order to account for partial blockage of the inlet with debris:

INLET TYPE & CONFIGURATION	CLOGGING FACTOR
Standard (Type SS-5 & SS-6) Curb Opening Inlets	
on grades	0.9
in sumps	0.8
Open-side Drop Inlet (Type DI-1)	
in sumps	0.9
(not used on grades)	---
Grated Inlets	
on grades	0.6
in sumps	0.5

Inlet lengths or areas shall be increased as required to account for clogging.

3. Interception And Bypass Flow. It is generally not practical for inlets on slopes to intercept one hundred percent (100%) of the flow in gutters. Inlets must intercept sufficient flow to comply with street flooding depth requirements. Bypass flows shall be considered at each downstream inlet, until all flow has entered approved storm sewers or drainageways.

4. Standard Inlet Types.

a. Curb Opening Inlets

The standard curb opening used in Springfield and Greene County has been very successful. However, there has been a considerable amount of confusion over inlet nomenclature. The common designations used (SS-5, SS-6, etc.) are based upon the page number on which the standard inlets appeared in the City of Springfield Design Standards. It is the intention of these standards to maintain commonly used terms while clarifying inconsistencies and confusion. The following standard curb inlet designations are recommended for use in City of Battlefield:

1. SS-5 Inlet. The standard SS-5 curb opening inlet shall refer to a shallow standard four foot by eight foot (4' x 8') curb opening inlet with a seven foot (7') long opening, located over a storm drain with a riser pipe connecting the inlet with the storm drain pipe. The type SS-5 inlet is shown in Figure SS-E7. Riser pipe capacities for use with SS-5 inlets are shown in Figure SS-E8.

2. SS-6 Inlet. SS-6 inlet shall refer to a full depth standard four foot by eight foot (4' x 8') curb opening inlet with a seven foot (7') long opening, which can also serve as a junction structure. The type SS-6 inlet is shown in Figure SS-E9. Precast SS-6 inlets may be provided with a six inch (6") precast top, known as a SS-6 top, or an eighteen inch (18") deep precast top, known as a SS-8 top (Figure SS-E10). The largest diameter pipe which can enter the short side of a SS-6 inlet is thirty inches (30").

3. SS-6S Inlet. SS-6S inlet shall refer to a 'short' SS-6 inlet, i.e. a full depth inlet with a four foot by four foot (4' x 4') exterior dimension and a three foot (3') long opening, which can also serve as a junction structure. SS-6S inlets are intended for use in sumps serving small areas.

4. SS-6G Inlet. SS-6G inlet shall refer to a SS-6 inlet modified to include a grate in the gutter. Grates used for SS-6G inlets shall be Deeter 2048L, Neenah R3076, or equal. Grates may not extend outward from the curb any further than the width of the standard gutter, which is two feet (2'). Vanes shall be oriented in the direction of gutter flow. The type SS-6G inlet is shown in Figure SS-E11.

5. Double Curb Inlets. Where necessary to meet allowable flooding depth criteria, two (2) curb opening inlets may be placed side by side. An opening shall be provided in the common walls between the inlets to provide flow from one inlet to the other. The opening shall be a minimum of eighteen inches (18") high and shall extend the entire interior width of the inlet box.

6. Construction Requirements. Curb opening inlets may be constructed of either pre-cast or cast-in-place concrete. Cast-in-place concrete construction shall meet the requirements of Chapter VII of the City of Springfield Technical Specifications

for Public Works Construction. Reinforcement shall be as shown in the standard details included in this section.

7. Special Inlet Box Designs. Where necessary to accommodate large diameter pipes, curb opening inlets may be specially designed. Details of concrete dimensions and reinforcement shall be included in the drawings.

b. Area Inlets

1. Open-Side Drop Inlets, Type DI-1. Open side drop inlets are intended for use in locations where open drainage channels, ditches, or swales terminate and flow enters the storm drain system, and flows range from ten (10) to one hundred (100) cubic feet per second. These inlets are preferred in order to minimize the risk of persons being swept into an open storm drain entrance.

The standard type DI-1 inlet is shown in Figure SS-E12. This inlet has a four foot by four foot (4' x 4') exterior dimension and a maximum capacity of about eighteen (18) cfs per opening at a maximum allowable depth of two feet (2'). The designer must stipulate on the drawing the number of open sides to be provided, i.e., 'Type DI-1 w/2 sides open', etc. Interception capacity data for standard DI-1 inlets are shown in Figure SS-E13.

Where additional capacity is needed, larger inlet structures can be used, provided dimensions are detailed on the drawings and interception capacity calculations are submitted. The maximum allowable opening height is six inches (6"). For greater opening heights, a horizontal bar shall be placed across the opening at maximum six inches (6") intervals.

2. Grated Area Inlets. Grated area inlets may be provided in parking lots and lawn areas. The maximum ponding depth over grated inlets shall be eighteen inches (18") for the major (100-year) storm. Concrete dimensions and reinforcement requirements for the inlet structure and the type of grate and frame to be used shall be specified on the drawings. Gratings shall be bicycle safe.

It is recommended that a two inch (2") depression be provided

for area inlets in paved parking areas in order to minimize standing water. It is also recommended that a reinforced concrete paving apron be provided for two feet (2') around the inlet in order to prevent pavement failure, and subsequent water ponding around the inlet (see Figure SS-E14).

5. Types of Inlets Allowed

a. Public Streets

1. Curb Opening Inlets. Standard curb opening inlets are required for use in public streets with curb and gutter. Curb openings are not permitted, except in situations where the drainage area is one-half (½) acre or less, and there is not sufficient grade to permit installation of a storm drain pipe.

2. Grated Inlets. In general, the use of grated inlets will not be permitted in streets, since these generally require adjustment when streets are re-paved.

Where conditions are such that curb inlets cannot intercept the required rate of flow necessary to control street flooding depth or to provide diversion of flow to detention, sedimentation, or infiltration basins, combination grate and curb opening inlets (Type SS-6G) may be used provided that the width of the grate is no greater than the gutter width. "Trench inlets" with vaned grates may be specified with approval of the City of Battlefield. Use of trench inlets will be permitted only when there is no practical alternative.

Other types of inlets will not be permitted unless approved by the City of Battlefield.

b. Outside of Public Right-of-Way

The type of inlets specified outside of public right-of-way is left to the discretion of the designer provided the following criteria are met:

1) Maximum flooding depths for the major or minor storm as set forth in Figure SS-E1 are not exceeded.

2) General safety requirements set forth in Section E.5 are met.

6. General Safety Requirements

All inlet openings shall:

a) Provide for the safety of the public from being swept into the storm drainage system. The maximum allowable opening for standard curb opening inlets and open side drop inlets shall not exceed six inches (6") in height. The maximum bar spacing for grated inlets shall be six inches (6"). Where the height of the opening exceeds six inches (6"), a three-quarters inch (3/4") diameter galvanized steel bar, or other approved restriction shall be provided horizontally across the opening at mid-height, or at maximum intervals of six inches (6"). The maximum open spacing between bars for grated inlets shall be six inches (6") in any direction.

b) Be sufficiently small to prevent entry of debris which would clog the storm drainage system.

c) Be sized and oriented to provide for safety of pedestrians, bicyclists, etc.

F. STORM SEWERS

This section covers the design of closed piping for conveyance of storm drainage. Design of open channels and other conveyances is covered in other sections.

1. General Requirements

a. Horizontal Alignment

Except for crossings, storm sewers shall not be located under streets. Storm sewers paralleling curbed streets shall be located such that the outside edge of the pipe is six inches (6") minimum behind the back edge of the curb. Pipes shall be aligned in straight lines. Curved alignments are not allowed.

Storm sewers located on private property shall be located within drainage easements and shall be aligned parallel with property lines unless otherwise approved. Where storm drains exit the street right-of-way between residential lots, the pipe shall be extended a minimum of forty feet (40') past the front yard setback line, or to the estimated location of the rear of the dwellings, whichever is more. The outside

edge of the pipe shall be located a minimum of five feet (5') from the easement line. Minimum easement widths are given in Table E.1.

TABLE E.1 MINIMUM EASEMENT WIDTHS

INSIDE HORIZONTAL DIMENSION	MINIMUM EASEMENT WIDTH
15"- 48"	15 FEET
54"- 72"	17.5 FEET
84" & 96"	20 FEET
OVER 96"	APPROVAL REQUIRED

b. Bends and Junctions

A manhole or junction structure must be provided at each change in direction or grade of the piping, EXCEPT that bends may be located at junction structures in order to provide a perpendicular connection. Bends must be provided at junction structures if the angle of entry is less than sixty (60) degrees (see Figure SS-F1). Pipes shall be aligned such that the direction of flow of any incoming pipe is not less than perpendicular to the direction of flow of the outflow pipe (i.e. flow "against the grain" shall be avoided).

Access manholes for junction structures shall not be located within the pavement area for public streets. Junction structures shall be located such that the outside edge of the access manhole is twelve inches (12") minimum behind the curb or from the edge of a retaining wall or other obstruction.

Access manholes shall be provided at a maximum of three hundred feet (300') spacing along the pipe.

Precast circular manholes, square cast-in-place or precast junction boxes, or inlets may be used for junction structures.

c. Vertical Alignment

The recommended minimum slope for storm drain piping is 0.5% (five-tenths percent). Pipe grades may not be less than the minimum friction slope required to convey the design flow, unless specifically approved. Maximum recommended grade is 10% (ten percent). Properly designed anchorage may be required for grades above 10%

(ten percent) and will be required for grades above 20% (twenty percent).

When changing pipe diameters, the inside tops of the pipes shall be set at the same elevation. Pipe size shall never be reduced downstream even though pipe slope and theoretical capacity may increase. A minimum vertical drop of 0.2' (two-tenths feet) shall always be provided across a junction structure, unless otherwise approved.

Under or within two feet (2') of streets or paved areas, the top of the pipe shall be located a minimum of twelve inches (12") below the pavement or curb subgrade, or greater if required to meet minimum cover and strength requirements for the type of pipe specified to withstand an AASHTO HS-20 loading. Outside of paved areas, the top of the pipe shall be located a minimum of twelve inches (12") below finished earth grade. Box culverts or other relatively wide and flat conveyance structures may be required to have additional cover if deemed necessary to support grass or other vegetative cover.

d. Clearance from Other Utilities

1. Horizontal Clearance:

Utility	Minimum distance from outside edge of pipe to centerline
Storm sewer	Inside diameter of largest pipe*
Sanitary sewer	Five feet (5')
Water, gas, electric line, or other utility	Five feet (5')

* or greater, if needed to allow proper placement and alignment of flared end sections

2. Vertical Clearance:

A minimum clear distance of twelve inches (12") from any other utility line shall be maintained above or below the storm drain pipe, unless otherwise approved.

e. Allowable Sizes

The minimum allowable inside diameter for any storm drain pipe on or connecting to storm drain piping in public right-of-way is fifteen inches (15"). The maximum allowable diameter is six feet (6'), unless otherwise approved.

f. Plan Requirements

Each storm drain line shown on the plan shall be numbered or lettered (Line 1, Storm1, Line A, etc.). Structures in each line shall be numbered or lettered in sequence beginning at the downstream end of the line. Stationing shall begin at the downstream end of the line and proceed upstream. Branch lines shall be numbered consecutively moving in an upstream direction. A continuous profile shall be drawn for each storm drain line.

2. Construction Materials

a. Types of Pipe Allowed

Storm sewers may be constructed of any of the following materials:

Material	Symbol	Standard
Reinforced concrete round pipe	RCP	ASTM C-76,Cl III
Reinforced concrete elliptical pipe	RCEP	ASTM C-507
Reinforced concrete pipe-arch	RCPA	ASTM C-478
Precast concrete flared end sections	FES	ASTM C-76
Corrugated, galvanized steel round pipe	CMP	ASTM A-760 AASHTO M-36
Corrugated, galvanized steel pipe-arch	CMPA	AASHTO M-167
Galvanized steel flared end sections	FES	ASTM A-760

Corrugated polyethylene pipe	CPP	ASTM D-1248
Cast-in-place reinforced concrete box culverts	RCB	MODOT Spec
Precast concrete box culvert	RCB	ASTM-789

Cast-in-place concrete pipe, masonry, vitrified clay, or other pipe not shown above is not allowed unless specifically approved.

Detailed information on structural and hydraulic properties of the type of pipe referred to above can be found in the Concrete Pipe Design Manual, the Handbook of Steel Drainage & Highway Construction Products and manufacturer's information for corrugated polyethylene pipe.

Corrugated polyethylene pipe (CPP) is not allowed within the public right-of-way or public drainage easements, unless approved in writing by the City of Battlefield.

b. Junction Structures

1. Precast Manholes

Precast concrete manholes shall conform to the requirements of ASTM-C478. Cast-in-place circular manholes are not permitted.

The following minimum manhole diameters shall be used:

Pipe Diameter	Minimum Inside Diameter of Manhole
15"-24"	Four feet (4')
27"-42"	Five feet (5')
48"	Six feet (6')
54"-66"	Eight feet (8')
>66"	Special junction structure

A minimum clearance of two feet (2') measured at the inside face of the manhole must be maintained between the outside edge of storm sewer pipes.

2. Junction Boxes

Square or rectangular junction boxes may be constructed of cast-in-place or precast concrete. Cast-in-place junction boxes shall be constructed as shown in Figure SS-F2.

Minimum horizontal dimensions for junction boxes are as follows:

Pipe Diameter	Minimum Inside Width of Junction Box
15"- 30"	Four feet (4')
36"- 42"	Five feet (5')
48"	Five feet six inches (5' 6")
54"	Six feet (6')
60"	Six feet six inches (6' 6")
66"	Seven feet (7')
72"	Seven feet six inches (7 '6")
>72"	Special approval required

Junction boxes shall not exceed eight feet (8') in depth measured from the interior invert of the junction box to the top of the junction box rim, unless structural calculations are submitted and approved.

Precast junction structures shall have a maximum inside horizontal dimension of eight feet (8') and a maximum depth of eight feet (8'), unless structural calculations are submitted and approved. Precast junction boxes shall be as manufactured by Rose-Con Pipe, Springfield, Missouri, or approval equal.

3. Hydraulic Design

a. Design Storm

Storm sewers shall be designed to convey the peak flow rate resulting from the required design storm having a rainfall intensity corresponding to the time of concentration at the point of interest, or a duration which produces the maximum runoff rate at the point of interest, depending upon the method used for computing runoff. It is preferred that storm sewers draining less than two hundred (200) acres be designed for runoff rates computed by the Rational Method.

1. Major (Emergency) System

Total drainage area less than one (1) square mile: 25-year (4% AEP) storm

Total drainage area one (1) square mile or more: 100-year (1% AEP) storm

In cases where no overland relief area is provided for the difference between the 25- and 100-year storm, storm sewers shall be designed to convey the 100-year storm.

2. Minor (Convenience) System

Storm sewers shall be designed to convey only intercepted flow necessary to maintain allowable street flooding depths, set forth in Figure SS-E1.

Reductions in peak flow rates to account for the effects of stormwater detention facilities located upstream will be allowed only in instances where the detention basin has been incorporated into an approved hydrologic model of the tributary watershed.

b. Storm Sewer Capacity

Storm sewers shall be designed to convey the peak flow rate from the design storm set forth in Section E.3.a while maintaining allowable maximum and minimum velocities, and without surcharging which would adversely effect the performance of inlets or other components or the drainage system, or cause flooding of structures or streets.

1. Allowable Hydraulic Grades

Maximum hydraulic grade elevation for the design discharge shall be six inches (6") below the lowest level of any inlet opening or twelve inches (12") below the rim of a junction box or manhole.

2. Pipe Capacity

Pipe capacity and velocity shall be computed using Manning's Equation:

$$Q = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Q = rate of flow, cubic feet per second

n = Manning's roughness coefficient, see below

A = cross sectional area of flow, square feet

P = wetted perimeter, feet

R = hydraulic radius = A/P, feet

S = slope

Type of Pipe	Manning's Roughness Coefficient
Reinforced concrete (all shapes, cast in place & precast)	0.013
Corrugated metal (annular corrugations)	0.024
Corrugated metal (helical corrugations)	0.011-0.024 (Use values recommended in Table 3.9 of the Handbook of Street Drainage and Highway Construction Products
Corrugated polyethylene (smooth wall)	0.013

3. Energy Grade Line (EGL)

The energy grade line is computed using the principle of conservation of energy and the energy equation for open channel or pressure flow, and is written as follows:

a. Open Channel Flow

$$z_1 + d_1 + \frac{V_1^2}{2g} = z_2 + d_2 + \frac{V_2^2}{2g} + H_L$$

b. Pressure Flow

$$z_1 + \frac{p_1}{\gamma} + \frac{V_1^2}{2g} = z_2 + \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + H_L$$

z = elevation (gravity) head, feet

d = depth of flow, feet

V = velocity of flow = Q/A, feet/second

P/γ = pressure head, feet

γ = unit fluid weight, pounds per cubic foot

H_L = total head loss, feet = $h_f + \sum h_m$

h_f = head loss due to friction, feet = L x S_f

L = pipe length, feet

S_f = pipe friction slope from Manning's Equation, feet/foot, $Sf = \left(\frac{Q}{C_1}\right)^2$

C_1 = conveyance = $\frac{1.49}{n} A R^{2/3} S^{1/2}$

h_m = minor head loss, at entrance, exit, bends, and junctions, feet (see below)

D = pipe diameter, or vertical dimension, feet

Q_f = pipe capacity at full flow, cubic feet per second

V_f = velocity at full flow, feet/second

V = velocity, feet/second

4. Hydraulic Grade Line (HGL)

Hydraulic grades are computed by subtracting the velocity head , $\left(V^2 / 2g \right)$, from the energy head. When the velocity is zero, the hydraulic grade line is coincident with the energy grade line.

5. Minor Head Losses

Minor head losses are computed as follows:

a. Pipe Entrance

$$h_c = K_c \frac{V^2}{2g}$$

Contraction coefficient, $K_c = 0.5$ (for square edge conditions)

$h_e = K_e \frac{V^2}{2g}$, Expansion coefficient, $K_e = 1.0$

b. Junction and Manhole Losses

$$h_j = \frac{V_2^2}{2g} - K_j \frac{V_1^2}{2g}$$

Junction loss coefficient, K_j, for use in the foregoing equation is as defined in Figure SS-F6. Other methods of computing junction and manhole losses are acceptable, provided they are documented in generally accepted literature.

c. Bends

$h_b = K_b \frac{V^2}{2g}$, Bend coefficient, K_b as follows:

Deflection at Bend	Head Loss Coefficient, K_b
90 degrees	0.50
60 degrees	0.43
45 degrees	0.35
22.5 degrees	0.20

4. Outlet Requirements

Storm sewer outlets shall be designed to allow expansion of flow and reduction of velocity, without undue risk of erosion downstream, and allowing for proper construction and maintenance of cut or embankment slopes at the outlet.

A headwall or flared end section shall be provided at all pipe outlets. Flared end sections and headwalls shall have a toewall extending a minimum of eighteen inches (18") below grade at their downstream end to prevent undercutting.

An erosion resistant lining of concrete or grouted riprap shall be provided for a distance equal to five (5) times the diameter of the outlet pipe or the box culvert width, downstream of the headwall apron or flared end section. The width of the grouted riprap shall be a minimum of two (2) times the pipe diameter or box culvert width or five feet (5'), whichever is less. Where velocity exceeds fifteen feet (15') per second at the pipe outlet an energy dissipator may be required. Energy dissipators shall be designed as set forth in the ASCE design manual.

G. OPEN CHANNELS

This section covers the evaluation of the capacity and stability of natural drainage channels, and design of constructed drainage channels, swales, and roadside ditches.

1. General Design Considerations

Except for roadside ditches and swales, open channels are nearly always a component of the **major** (emergency) drainage system. There are a number of factors which must be considered in determining whether to specify an open drainageway as opposed to an underground storm drain: material and installation cost, maintenance costs and problems, acceptability to the developer or home buyer, public safety, appearance, etc. Effective planning and design of open drainageways can significantly reduce the cost of storm drainage facilities, while enhancing the quality of the development.

In planning a subdivision, the designer should begin by determining the location and the width of existing drainageways. Streets and lots should be laid out in a manner to preserve the existing drainage system to the greatest degree practical. In addition to reducing the cost of the drainage system, sediment and erosion control costs will also be reduced. Constructed channels should be used only when it is not practical or feasible to utilize existing drainageways.

2. General Design Requirements

a. Design Flow

Open channels shall be designed to convey the peak flow rate resulting from a storm having a rainfall intensity corresponding to the time of concentration at the point of interest or a duration which produces the maximum runoff rate at the point of interest, depending upon the method used for computing runoff. Open channels draining less than two hundred (200) acres can be designed for runoff rates computed by the Rational Method. The peak flow rate considered shall be determined using fully urbanized conditions in the watershed. Effects of detention basins in reducing peak flow rates in the upstream watershed will be considered only if the detention basins are included in a hydrologic model used to estimate the peak flow rate and provided the detention basins are located in permanent drainage easements.

The design storm frequency shall be as follows:

Total drainage area less than one (1) square mile: 25-year (4% AEP)
Total drainage area one (1) square mile or more: 100-year (1% AEP)

b. Maximum Depth

Unless otherwise approved due to unavoidable physical or right-of-way constraints, the maximum depth for the 25-year storm shall be three feet (3') in constructed channels.

c. Freeboard

For channels designed for subcritical flow conditions, a minimum of one foot (1') of freeboard shall be provided between the design high water elevation and the top of the channel.

Freeboard shall be increased on the outside of curves according to the following formula:

$$h = \frac{\left[V^2 T\right]}{g r_c} \geq 0.5 ft.$$

h = superelevation (feet)
V = average channel velocity (feet/second)
T = top width of flow (feet)
g = acceleration due to gravity (32.2 ft/s^2)
r_c = centerline radius of channel (feet)

For channels designed for supercritical flow, additional freeboard may be required depending upon the risk of damage which could occur if flow were to become subcritical due to debris or other obstructions.

d. Horizontal Alignment

The centerline of constructed channels shall be aligned parallel with property lines unless otherwise approved. A radius shall be provided whenever the alignment of a constructed channel changes by ten (10) degrees or more. The minimum centerline radius shall be three (3) times the top width of the design flow.

Horizontal curve data shall be shown on the plans.

e. Easements

All constructed channels shall be located within drainage easements. Natural channels draining five (5) or more acres shall be located in drainage easements. The minimum easement width shall be the top width of the 100-year peak flow rate. Adequate means of access shall be provided for maintenance equipment. Additional easement width shall be provided if required to provide maintenance access.

No fences or obstructions of any type are permitted within drainage easements containing open channels.

f. Grades

Unless otherwise approved due to unavoidable physical constraints, the minimum centerline grade for various channels shall be as follows:

Concrete channels	0.25%
Composite channels with concrete inverts	0.5%
Grass channels	1.0%
Grass channels with concrete trickle channels	0.5%
Riprap and gabion channels	1.0%
All other channel types	Will be considered on a case by case basis

g. Allowable Velocities

The maximum average channel velocity shall be as follows for the design flow rate:

Channel Lining Type	Maximum Average Velocity, V
Grass	5 feet/second
Concrete	15 feet/second
Riprap, gabion	10 feet/second

Where reduction in velocity due to a reduction in slope would allow a transition from a concrete to a grass-lined channel, a grouted riprap lining shall be provided from the point where the theoretical average channel velocity would be five feet (5') per second or less, for a

distance downstream equal to five (5) times the theoretical top width of the grass channel. The height of the riprap lining shall be equal to the height of the concrete lining upstream.

h. Utility Clearances

A minimum clear distance of twelve inches (12") vertically from any other utility line shall be maintained below the channel lining, unless otherwise approved. Utilities will not be permitted to cross through the channel flow area.

i. Plan Requirements

Each channel shown on the plan shall be numbered or lettered (Line 1, Storm 1, Line A, etc.). Channel segments shall be included in profiles of the storm sewer lines of which they are a component. Stationing shall begin at the downstream end of the channel and proceed upstream. Stations shall be called out on the plan and profile at all changes in direction or points of curvature and tangency.

3. Hydraulic Design

a. Uniform Flow

Open channels having a design flow rate less than five hundred (500) cfs may be designed assuming uniform flow conditions in conjunction with computed headwater depths at culverts and other hydraulic structures or reservoir stages at detention and sediment basins. Water surface profiles using techniques for gradually varied flow may be required for design flow rates less than five hundred (500) cfs where accurate determination flooding depths is necessary to ensure flood safety.

Under steady state, uniform flow conditions channel capacity shall be computed using Manning's Equation:

$$Q = \frac{1.49}{n} A \ R^{2/3} S^{1/2}$$, where

Q = rate of flow, cubic feet per second
n = Manning's roughness coefficient (See Table G.1 below)
A = cross sectional area of flow, square feet
P = wetted perimeter, feet

R = hydraulic radius = A/P, feet
$S = S_f$ = friction slope

TABLE G.1
MANNING'S ROUGHNESS COEFFICIENT FOR VARIOUS CHANNEL LININGS

Type of Surface	Manning's n Value
Concrete, float finish	0.013-0.015
Gunite, shotcrete	0.016-0.019
Concrete bottom, with pre-cast masonry unit sides	0.020-0.030
Gravel bottom with pre-cast masonry unit sides	0.023-0.033
Riprap, Note 3	0.050-0.060
Grouted riprap, Note 3	0.023-0.030
Grass Channels, VR>10	0.030-0.035
VR<10	0.030-0.200 (See Section G.4.b)
Stream Channels: gravel, cobbles, few boulders	0.040-0.050
Floodplains	
Short grass pasture, hayfield	0.030-0.035
Tall grass pasture, hayfield	0.035-0.050
Mature field crops	0.040-0.050
Heavy weeds, scattered brush	0.050-0.070
Light brush and trees	0.060-0.080
Medium to dense brush	0.100-0.160
Heavy stand of timber, a few down trees, little undergrowth	0.100-0.120

1. Definitions

Critical depth, dc - the depth of flow at which the specific energy is a minimum for a given flow rate and channel cross shape, and a unique relationship exists between depth and specific energy.

Normal depth, dn - the depth at which uniform flow occurs when the discharge rate is constant. Friction and gravity forces are in balance.

Subcritical flow - lower energy, lower velocity flow, which occurs when the normal depth is greater than the critical depth. Subcritical flow is controlled by downstream conditions.

Supercritical flow - high energy, high velocity flow, which occurs when the normal depth is less than the critical depth. Supercritical flow is controlled by upstream conditions.

Froude number, $F_r = \frac{V}{\sqrt{gD}}$, where

D = hydraulic depth (feet) = A/T
A = cross sectional area of design flow (square feet)
V, g and T are as defined in Section G.2.c

For supercritical flow, $F_r > 1$
For subcritical flow, $F_r < 1$
For critical flow, $F_r = 1$

Specific energy, E, is the energy per unit weight of fluid

$$E = d + \frac{V^2}{2g}, \text{ where}$$

E = specific energy in feet
V and g are as defined above
d = depth of flow in feet

Specific force, Fm, is the sum of forces due to velocity plus hydrostatic pressure per unit weight of fluid

$$F_m = \frac{Q^2}{gA} + A\bar{y}, \text{ where}$$

F_m = specific force in cubic feet
$\bar{y}$ = depth to center of gravity of the cross section in ft
Q and A are as defined above

Conjugate depth (also known as alternate depth) is the corresponding subcritical or supercritical depth having the same value of specific energy or specific force.

2. Computations for all channels designed for uniform flow

conditions shall indicate whether flow is subcritical, critical or supercritical. It is preferred that channels be designed for subcritical flow conditions. Critical flow ($0.9 < F_r < 1.2$) should be avoided, if possible, since flow is unstable. Where channels must be designed for supercritical flow and the Froude number is greater than two point five (2.5), the conjugate depth for specific force must be determined. Freeboard up to the conjugate depth may be required if necessary to provide adequate flood protection.

b. Gradually Varied Flow

Open channels having a design flow rate of five hundred (500) cfs or more and which are not relatively long with a uniform cross section, shall be designed for gradually varied flow. Manual computations shall be done using the Direct Step Method or Standard Step Method . Water surface profiles can be computed using the Corps of Engineers HEC-2 Water Surface Profiles program or the Federal Highway Administration WSPRO program.

c. Rapidly Varied Flow

Rapidly varied flow conditions shall be avoided when possible. Where drop structures are required for grass lined or composite channels, the location of the hydraulic jump and the length of erosion protection to be provided shall be determined in accordance with the procedures set forth in Section G.4.e.

Check dams and other special hydraulic structures shall be designed as set forth in the ASCE Design Manual.

4. Design & Construction Requirements

a. Natural Channels

1. Perennial Streams and Losing Streams

The stream channel of perennially flowing streams or intermittent streams classified as losing streams in the Missouri Clean Water Laws shall not be modified or channelized except where unavoidable to construct road crossings or to repair erosion and stabilize the stream channel.

Trees and vegetation shall not be removed within twenty-five feet (25') of the stream bank. Clearing of brush and undergrowth shall be minimal. It is preferred that existing vegetation remain within one hundred feet (100') of the stream bank.

Work within the stream channel may require a Department of the Army "404" permit.

2. Tributary Watercourses

Intermittent streams which have a defined channel should not be modified or channelized except where unavoidable for road crossings or to repair erosion and stabilize the stream channel. No clearing is permitted within twenty-five feet (25') of the stream bank except to remove underbrush and fallen timber.

Natural watercourses in which flow is broad and shallow, and which have no defined channel should not be modified or channelized. Removal of trees and vegetation within the watercourse should be avoided as much as practical.

3. Determining Flooding Limits for Watercourses

The area inundated by the peak flow from the 100-year (1% AEP) storm is considered to be the flooding area for any watercourse. An implicit drainage easement is considered to exist along the area inundated by the peak flow from the 1% AEP (100-year) storm.

For the purpose of preliminary planning and design, the approximate limits of the floodplain can be determined using approximate methods.

In determining the capacity and depth of flow in natural watercourses, they shall be analyzed by selecting the most restrictive channel section for each reach and determining the normal depth by analyzing the channel as an irregular section using representative "n" values for each segment of the channel cross-section.

4. Development Guidelines

Where the width of the existing drainageway cannot accommodate the needs of the development, the fringe areas of the drainageway can be filled, and tributary watercourses may be channelized within the limitations described above. The combination of filling and channeling shall not increase the estimated high water elevation for the 100-year (1% AEP) peak flow rate by more than one foot (1') over pre-project conditions at the upstream boundary or any point upstream of the site.

Where the effects of increased frequency of flow or increased velocity may significantly effect the stability or the stream channel, measures such as grade checks, check dams or bank stabilization may be required.

A typical natural channel cross section is shown in Figure SS-G1.

b. Grass Channels

Grass lined channels shall have a minimum slope of 1% (one percent). The bottom slope may be decreased to 0.5% (five-tenths percent) if a concrete trickle channel is provided.

Maximum side slopes shall be 3:1, with 4:1 preferred.

In order to establish growth in the channel bottom, the bottom twelve inches (12") of the channel depth shall be lined with sod, or suitable erosion control blanket.

A typical grass lined channel cross section is shown in Figure SS-G2.

Manning's roughness coefficient ("n", also known as the retardance coefficient) for grass channels shall be determined based upon the product of the velocity and the hydraulic radius (V x R) using the chart shown in Figure SS-G3 . Retardance curve "C" shall be used in determining channel capacity. Retardance curve "D" shall be used in determining velocity.

c. Low Flow (Trickle) Channels

Trickle channels shall be provided in *constructed* grass channels (not natural channels) where base flow or perennial flow prevents the establishment or re-establishment of a sod bottom. Types of trickle channels are as follows:

1. Concrete Trickle Channels

Trickle channel capacity shall be approximately five percent (5%) of the design flow rate. A standard concrete trickle channel cross-section is shown in Figure SS-G4. Other shapes may be used, provided capacity calculations are submitted and construction details are provided on the plans.

Concrete trickle channels may be unreinforced up to a total width of five feet (5'). For total widths of five feet (5') to ten feet (10'), the trickle channel shall be reinforced with 6 X 6-10-10 welded wire mesh. For widths greater than ten feet (10'), see requirements for concrete channels.

Trickle channel alignment shall be the same as the overall channel alignment. Radii at changes in direction shall be the minimum radius required based upon the channel top width.

Capacity of grass channels with trickle channels may be determined as a composite cross-section in accordance with Section G.4.c , or the additional capacity of the trickle channel can be ignored.

A typical cross section of a grass channel with a concrete trickle channel is shown in Figure SS-G5.

Erosion potential at the grass/concrete interface should be checked. Shear stress or tractive force shall be determined as follows and shall be limited to the maximum values set forth below:

Shear force, $\tau = \lambda ds$, where

τ = unit shear stress (pounds per square foot)
λ = unit weight of water = 62.4 pounds per cf
s = channel slope (feet per foot)

d = distance from the water surface to the channel lining at the point of interest (feet)

TABLE G.2

Maximum Allowable Shear Stress for Various Lining Types

Lining Type	Maximum Shear Stress
Grass, sod	0.60 psf
Jute fiber net	0.40 psf
Straw erosion control blanket with attached netting	1.45 psf
Excelsior (wood fiber) erosion control blanket with netting	1.55 psf
Synthetic erosion control blanket	2.00 psf

The foregoing values were obtained from Table 9.5 of the ASCE Design Manual Manufacturer's data shall be submitted for erosion control blankets specified.

2. Other Types of Trickle Channels

Trickle channels of porous pavers, gravel filled Geoweb, submerged flow wetlands, natural stone and other materials can be specified, and are encouraged to improve aesthetics and water quality. However, assurance must be given that quality control will be maintained during construction and that adequate maintenance will be provided after construction.

Complete computations and construction specifications must be submitted for alternative types of trickle channel linings.

d. Composite Channels

Many different channel shapes and lining types are possible. Different shapes and lining types can be combined in a composite design. In determining the capacity and depth of flow in composite channels, they shall be analyzed as an irregular section using representative "n" values for each segment of the channel cross-section. Velocity limitations set forth above shall be adhered to for each lining type. Allowable shear stress at the interface between grass or other erodible

linings and erosion resistant linings may not exceed the maximum values set forth in Table G.4.c.

A typical cross section of a channel with a concrete invert and grass slopes is shown in Figure SS-G6.

e. Concrete Channels

Where velocities or slopes cannot be limited to values required for natural, grass, or composite channels due to right-of-way or other constraints, concrete channels may be utilized. Concrete channel shapes will typically be trapezoidal or rectangular. Other shapes may be used, but are less efficient.

Crushed rock bedding and pore pressure relief are required whenever the lining height exceeds twelve inches (12"). Whenever the concrete channel bottom is wide enough to accommodate construction or maintenance equipment (generally eight feet (8') wide or more), it shall be designed to carry an HS-20 leading and shall be reinforced. Welded wire mesh or steel reinforcing bars shall may by used.

Concrete channels shall be designed for subcritical flow where possible. Where flow is supercritical, the conjugate depth must be checked and additional freeboard may be required as provided in Section G.2.c.

Where slopes must be decreased to provide stability or maintain subcritical flow, drop structures should be provided.

1. Trapezoidal Concrete Channels

Maximum side slopes shall be 2:1. Total channel depth is limited to three feet (3') unless otherwise approved. For depths greater than twelve inches (12"), the channel slopes shall be reinforced with 6 X 6-10-10 welded wire mesh. A typical trapezoidal concrete channel section is shown in Figure SS-G7.

2. Rectangular Concrete Channels

Vertical side walls shall be reinforced to withstand earth pressure and other anticipated loads. Design for hydrostatic pressure is not required if weep holes are provided for relief. A typical rectangular concrete channel section is shown in

Figure SS-G8.

A toe wall extending a minimum of eighteen inches (18") below grade shall be provided at the downstream end of any concrete channel section, and should be provided at maximum intervals of about one hundred feet (100') along the channel.

f. Riprap Linings

The use of riprap for channel linings is discouraged primarily due to poor construction practice. Because of the amount of labor required to properly place and chink stones into a stable mass, loose riprap is seldom stable. Further, gradations of stone tend to be highly variable and poorly controlled.

Loose riprap is susceptible to silting in, encouraging growth of weeds and vegetation, and creating a maintenance and appearance problem. These problems can be overcome somewhat by grouting the riprap; however, construction practice for grouted riprap is equally poor resulting in a highly variable penetration by the grout.

Riprap linings are best specified for only short distances in zones where erosion potential is high. Where riprap is specified it should be grouted to minimize maintenance problems, unless the installation is temporary. The maximum stone size should be twelve inches (12"). The riprap shall be laid over a non-woven filter fabric in order to prevent undercutting of the subgrade.

A typical riprap lining is shown in Figure SS-G9.

g. Other Types of Erosion Resistant Channel Linings

Designers are encouraged to use other types of linings in order to reduce cost and improve appearance of drainage channels. Invert lining materials include concrete, reno mattresses, gravel filled Geoweb, Geoweb filled with lean concrete, etc.

Sidewall lining materials include gabions, and precast concrete units, such as Keystone blocks, Loffelstein units, Windsor stone, and many other types of precast units.

In specifying any type of these linings, the manufacturer's installation instructions shall be strictly followed.

h. Drop Structures

Where the channel slope must be decreased to provide stability, maintain subcritical flow, or reduce velocity to acceptable levels, drop structures may be provided. Grass lined channels shall be provided with erosion resistant linings downstream to the point at which the average channel velocity has returned to the allowable rate for the type of channel lining provided. Drop structures for vertical wall channels shall be designed in accordance with the ASCE Design Manual or the U.S. Bureau of Reclamation Design of Small Canal Structures. Drop structures for trapezoidal channels shall be designed in accordance with the City of Tulsa Design Criteria or King's Handbook of Hydraulics.

5. Roadside Ditches

Roadside ditches shall be designed for a maximum depth of two feet (2') measured from the roadway shoulder, and maximum 3:1 side slopes. Roadside ditches shall be grass lined and shall conform to the same velocity requirements as grass lined channels. The bottom six inches (6") of the ditch depth shall be lined with sod or erosion control blanket, or the developer must assume maintenance responsibility for the ditch until growth is firmly established. A security agreement or performance bond will be required during the maintenance period.

Where the full flow velocity in the ditch exceeds five feet (5') per second, a concrete ditch liner as shown in Figure SS-G10 shall be provided.

H. DETENTION FACILITIES FOR FLOOD CONTROL

This section covers the design of detention facilities whose primary purpose is to provide flood control by controlling rates of runoff. Detention facilities may also be utilized to improve the quality of urban stormwater runoff. The design of detention facilities for water quality improvement is covered in Section J, Stormwater Quality. Both flood control and water quality benefits can be provided in one (1) basin, if properly designed.

1. Policy

Prior to the development of the land, surface conditions provide a higher percentage of permeability and a longer time of concentration. With the construction of buildings, parking lots, etc., permeability and the time of concentration are significantly decreased, resulting in an increase in the rate,

volume, and frequency of runoff.

These changes result in increased flooding risk to downstream structures, since flooding depths will rise as the rate of runoff increases. The increased volume and frequency of runoff can cause erosion damage.

In order to minimize these effects, stormwater detention requirements have been established. All new non-agricultural construction is required to provide stormwater detention facilities. Detention requirements may be waived upon written approval of the City of Battlefield in the following cases:

a. Construction of such a facility would, due to timing of outflows, have an adverse effect on downstream properties by increasing peak rates of runoff, as demonstrated by engineering computations;

b. The developer enters into a written agreement with the County and affected property owners to provide storm drainage improvements downstream of the development in lieu of constructing on-site detention facilities as set forth below; or

c. Due to the small size of the development, it can be demonstrated that the detention facility would result in no beneficial effect to downstream properties. Detention basins having a required volume of five thousand (5,000) cubic feet or less are considered as providing only marginal benefits.

In Cases 1 and 3 above the City may, in the future, impose a fee in lieu of detention to be utilized for maintenance or improvement of storm drainage facilities in the same watershed in which the proposed development is located.

Detention requirements cannot be waived if there are residential or other structures downstream of the site which have a high flooding risk as defined in Section H.2.

Construction of Improvements in lieu of Detention

In cases where channelization or other improvements can be shown to be more effective than detention in reducing the flooding hazard to downstream properties and where no adverse effects to downstream properties will result from construction of such improvements, the City may enter into an agreement with the applicant to accept compensation and/or construction of off-site improvements in lieu of

constructing on-site detention facilities.

The developer's contribution will be determined based upon the net financial gain which the developer would realize if the detention facility is not built. This amount will generally be equal to the construction cost of the detention facility plus revenue from sale of additional lots or increased value of lots, less the cost of developing the lots, including utilities and streets, financing costs, sales costs, and reasonable profit.

Where the developer's contribution is not sufficient to construct the necessary improvements to completely remedy flooding problems to structures downstream, the City must demonstrate that the necessary funding has been secured prior to accepting payment or improvements in lieu of detention. Where the developer's contribution is more than the actual cost of the necessary improvements, the City shall retain the balance and such funds shall be utilized for planning or construction drainage improvements in the same watershed.

2. Definitions

Pre-project conditions - the topography, surface cover, and other hydrologic conditions in the watershed being considered, as they exist prior to the proposed project.

Post-project conditions - the topography, surface cover, and other hydrologic conditions in the watershed as they will be after construction of the proposed project.

Fully urbanized conditions - the topography, surface cover, and other hydrologic conditions in the watershed as they will be after all areas in the watershed have been developed in accordance with current zoning designations, as provided in the City of Battlfield Comprehensive Plan, or as can otherwise be reasonably anticipated.

High flooding risk - residences or other structures will be defined as having a high flooding risk when the lowest point on the structure at which surface runoff may gain entry is located at, or below, the estimated flooding level which would result from a storm with an annual exceedance probability (AEP) of 10% (ten percent) or greater under conditions existing in the basin prior to development of the applicant's property (i.e. affected by the "10-year" storm for pre-project conditions).

Dry detention basin - a detention basin which holds water only during and shortly after runoff events.

Wet detention basin - a basin which contains a permanent impoundment of water. Flood storage volume is provided above the permanent water surface.

Retention basin - this term is often utilized for wet basins and basins which retain runoff for an extended period of time. The term "detention basin" will be used to refer to all such facilities in City of Battlfield.

On-line detention basin - a basin which is located on the main stream of a watercourse and which intercepts on-site as well as off-site flows.

Off-line detention facility - a basin or basins located outside of the primary watercourse, which usually allows off-site flows to pass through the site without passing through the detention basin. Where needed for peak flow reduction at the point of interest, a portion of the flow in the main watercourse may be intercepted and passed through the detention basin through the use of side-flow weirs or similar diversions.

3. General Design Requirements

Detention facilities should be designed and constructed in a manner to enhance the aesthetic and environmental quality of developments in the County as much as possible, adding to rather than detracting from property values. City of Battlefield encourages designs which utilize and enhance natural settings, provide good quality open space, and minimize disturbance and destruction of wooded areas, natural channels, and wetlands.

Where detention volume can be provided by utilizing natural valleys, existing wooded areas should be allowed to remain. Detention ponds do not have to be graded to geometric shapes or cleared of forested areas in order to comply with City requirements.

The use of landscaping and alternative materials to improve the appearance of spillways, outlet structures, erosion control, and energy dissipation structures is encouraged.

Detention basins may be designed to be "wet" or "dry". Parking lots may be utilized for detention storage, provided the maximum depth does not exceed eighteen inches (18"). Underground detention storage may also be utilized. The use of rooftop detention is discouraged. Detention basins may be designed to be "on-line" or "off-line".

Large regional detention basins are more effective in providing flood control, as well as water quality benefits, than smaller facilities provided on each site. City of Battlefield currently has no program for regional detention. Where feasible, developers are encouraged to work together to provide common detention areas.

Detention basins shall be located within a single lot or property.

a. Easements

All detention basins serving more than one (1) lot or property shall be located within a drainage easement.

At a minimum, the easement shall include the area of the dam, the area downstream of the dam to a point twenty feet (20') downstream of the end of the outlet structure, including the area provided for erosion control or energy dissipation; and the area covered by the reservoir including freeboard, plus an additional twenty feet (20') around the perimeter.

Detention basins for a development may be located on adjoining property downstream from the development provided that a drainage easement is obtained and adequate means of maintenance access (including ingress/egress easements where necessary) is provided. The easement shall be granted to the developer or to property owners' association. Where the detention basin does not immediately adjoin the development, a drainage easement covering the area inundated by the peak flow from the 1% AEP (100-year) storm shall be provided to connect the development site with the detention basin.

4. Ownership and Maintenance

City of Battlefield provides no maintenance of detention facilities located on private property. Maintenance must be provided by the owner of the property upon which the detention basin is located.

Where detention basins are located in common areas or adjoining off-site areas, the property upon which the basin is located shall remain in the ownership of the property owners' association.

Where a property owners' association is formed, restrictive covenants which provide for collection of fees for maintenance of the detention facilities shall be filed in the office of the Greene County Recorder of Deeds. Restrictive

covenants must be approved by the City legal counselor prior to filing of the final plat.

5. Storage Volume Computations

a. Analytical Methods

Detention storage volume shall be determined by hydrograph methodologies and reservoir routing techniques. Preferred methods for use in detention basin design are those included in the Corps of Engineers HEC-1 Flood Hydrograph Package and the Soil Conservation Service's TR-55 and TR-20.

The designer may choose to use other methods than those listed above provided that the method is documented in generally accepted engineering literature and is used within the limitations stated for the method.

b. Computations for Small Sites

Where the site area is less than five (5) acres of one (1) and two (2) family dwellings, or where the site area for other zoning designations is less than two (2) acres, detention volume computations may be performed by the methods of the Soil Conservation Service TR-55.

Runoff volumes shall be computed for pre- and post-project conditions, and the required volume determined by subtracting the pre-project runoff volume from the post-project runoff volume. The outlet structure shall be designed to limit the runoff rate for the design storms set forth in Section H.3.b to pre-project values at the stage where the required volume for each storm frequency is contained in the basin.

c. Design Storms

Detention basins shall be designed on the basis of multiple storm recurrence frequencies to ensure that they provide flood protection for both frequent storms and large infrequent storms. A minimum of three (3) recurrence frequencies, the 50%, 10% and 1% AEP storms (the "2-year, 10-year and 100-year" storms) must be considered.

The duration of the design storm used to compute the difference in

runoff volume between pre-project and post-project conditions shall be that which produces the maximum rate of runoff at the point under consideration for post-project conditions. The minimum design storm duration utilized shall be one (1) hour.

d. Runoff Models

The runoff model must include the entire drainage basin upstream of the proposed detention pond. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

Runoff models shall be developed for the following cases:

Case 1. Pre-project conditions.

Case 2. Post-project conditions.

Case 3. Fully urbanized conditions in the entire drainage basin.

Cases 1 & 2 are utilized to determine the required detention volume and the type of outlet structure to be provided, and shall be analyzed for the three (3) storm recurrence frequencies required above.

Detention facilities shall be designed such that peak outflow rates from the facility for Case 2 are no greater than the rates determined in Case 1 for each of the three (3) storm recurrence frequencies required.

The storage volume provided shall not be less than the difference in total runoff volume between Case 1 and Case 2.

Case 3 is used to determine the size of the overflow spillway. Case 3 need only be analyzed for the 1% AEP ("100-year") storm.

e. Spillways and Outlet Structure Hydraulics

Outlet structures be composed of culverts, weirs, orifices, and other hydraulic elements for which reliable data is available. Weir coefficients shall be as given in King's Handbook of Hydraulics. Coefficients for broad-crested weirs interpolated from the values given in King's Handbook are given below in Table H.1.

TABLE H.1
DISCHARGE COEFFICIENTS FOR BROAD-CRESTED WEIRS

Depth (ft.)	Coefficient for 6" thick wall	Coefficient for 8" thick wall	Coefficient for 12" thick wall
0.20	2.80	2.77	2.69
0.25	2.83	2.79	2.70
0.30	2.86	2.80	2.71
0.40	2.92	2.84	2.72
0.50	3.00	2.90	2.74
0.60	3.08	2.95	2.75
0.70	3.19	3.03	2.80
0.75	3.25	3.08	2.83
0.80	3.30	3.12	2.85
0.90	3.31	3.16	2.92
1.00	3.32	3.20	2.98
1.25	3.32	3.25	3.11
1.50	3.32	3.29	3.24
1.75	3.32	3.31	3.27
2.00	3.32	3.32	3.30
2.50	3.32	3.32	3.31
>2.5	3.32	3.32	3.32

Capacity of broad-crested slot and V-notch weirs shall be determined by the following formula, developed by Joe Wilson, Kerry Scott, and Larry Wolf at the University of Missouri-Rolla:

$$Q = 0.86H + (3.65w + 5.82z)H^{1.5}$$, where

Q = flow rate in cubic feet per second.
H = upstream head (ponded depth above slot invert plus any velocity head) in feet. H = 6 feet maximum.
w = slot invert width perpendicular to flow, in feet $0.333 < w < 2.0$ feet.
z = slope of slot sides expressed in terms of z horizontal to 1 vertical. $0 < z < 0.6$

A definition sketch for V-notch spillways are shown in Figure SS-H1.

Weir coefficients for trapezoidal weirs shall be determined based upon the ratio of headwater depth to crest width, as shown in Figure SS-H2.

Culvert capacities shall be determined using the methods in Federal Highway Administration HDS-5.

Weir coefficients for trapezoidal weirs where the depth of flow over the weir is small in comparison to the width of the weir crest shall be determined in accordance with Figure III-11 of Federal Highway Administration HDS-5.

Discharge coefficient for all orifice shapes shall be 0.6 (six tenths) unless supporting data is submitted for other values.

Where outlet structure capacities are determined automatically by the software used in performing the detention basin analysis, values included in the software package may be used provided they are generally accepted and properly documented.

f. Submittals

The following information must be submitted with detention basin designs:

1. Information regarding analytical methods and software to be used, including:

   - Name of software to be used.
   - Type and distribution of precipitation input.
   - Method for determining precipitation losses.
   - Type of synthetic hydrograph.
   - Method for routing hydrographs.
   - Method used for reservoir routing.

2. Map(s) showing sub-basin delineation, topography, presumed flow routes, and pertinent points of interest for pre-project, post-project and fully urbanized conditions.

3. Map showing hydrologic soil types.

4. Routing diagram for each runoff model condition.

5. A summary of sub-basin characteristics used for program input.

6. Stage-area or stage-storage characteristics for the basin in

tabular or graphic form.

7. Stage-discharge characteristics for the outlet structure and overflow spillway in tabular or graphic form; hydraulic data for weirs, orifices, and other components of the control structure.

8. A printout of the input data file.

9. A printout of program output, including plots of hydrographs. (These are intended to be the printer plots generated by the software.)

6. Construction Requirements

a. Maximum and Minimum Slopes

Maximum slopes of excavated or embankments slopes shall be 3:1. 4:1 slopes are preferred. Natural slopes exceeding 3:1 may be utilized provided that they remain undisturbed.

The minimum allowable slope on the bottom of the basin shall be 1% (one percent) unless a trickle channel is provided. Trickle channels shall be designed as provided in Section G.4.c.

b. Earth Dams

Dams shall be constructed to the maximum slopes specified above. Dams shall be constructed of properly compacted earth fill and shall be keyed into existing ground to reduce the risk of leakage or failure.

Dams less than ten feet (10') in height shall be keyed in a minimum of two feet (2') below existing grade. Deeper keys may be required for taller dams.

The minimum embankment width at the top of the dam shall be three feet (3'). Greater widths may be required for dams exceeding ten feet (10') in height.

Dams greater than thirty-five feet (35') in height are subject to regulation by the State dam safety program, and shall meet requirements of the dam safety program.

c. Concrete Retaining Walls

The use of vertical retaining walls for detention basin impoundments is discouraged, due to cost and appearance considerations. However, concrete retaining walls are frequently utilized to minimize the area required for detention basins.

Where concrete retaining walls exceed three feet and six inches (3' 6") in height, a four feet (4') high chain link or solid fence must be provided.

The maximum depth of detention basins using vertical walls shall be four feet (4').

Concrete retaining walls shall be designed to withstand earth and hydrostatic pressures. Walls longer than fifty feet (50') shall be provided with expansion and contraction joints at appropriate intervals.

d. Other Types of Retaining Walls

Where retaining walls must be utilized to conserve space, the use of other types of materials is encouraged in order to reduce cost and improve appearance of detention basins. Alternative retaining wall materials include gabions and precast concrete units, such as Keystone blocks, Loffelstein units, Windsor stone, and many other types of precast units.

In specifying any type of these linings, the manufacturer's installation instructions shall be strictly followed.

e. Freeboard

For basins with a surface area of two (2) acres of less, a minimum freeboard of twelve inches (12") shall be provided above the design stage for the 1% AEP (100-year) storm. For surface areas greater than two (2) acres but less than ten (10) acres, two feet (2') of freeboard shall be provided. Greater depths of freeboard may be required for impoundments having a surface area greater than ten (10) acres.

f. Spillways and Outlet Structures

Any type of outlet structure and overflow spillway can be utilized provided the required hydraulic characteristics of the structure can be maintained and provided that no undue maintenance burdens are

placed upon the owner of the detention basin.

Outlet structures and spillways shall be provided with an adequate stilling area downstream to reduce velocities to acceptable levels. Outlet structures shall be set back a minimum distance from the downstream property line to allow for the pre-project velocity and spread of flow to be maintained at the downstream property line.

Where concrete or other types of retaining walls exceed three feet and six inches (3' 6") in height, a four feet (4') high chain link or solid fence must be provided.

Spillways and outlet structures shall be provided with toewalls extending a minimum depth of eighteen inches (18") below finish grade at the upstream and downstream ends in order prevent undercutting.

Spillway sidewalls shall extend in height to the top of the dam.

g. Wet Ponds

Where wet ponds are specified, the pond lining must be designed to retain water. Geologic conditions in Greene County frequently make it difficult for impoundments to hold water. Site soil conditions shall be evaluated by a soils engineer and an appropriate lining provided.

Wet ponds shall have a minimum permanent pool depth of four feet (4') to minimize algae growth. Designers and developers are encouraged to consult with the Missouri Department of Conservation regarding pond management techniques, stocking fish, etc.

I. EROSION & SEDIMENT CONTROL

1. Purpose

The goal of the regulation is to effectively minimize erosion and discharge of sediment from construction sites by application of relatively simple and cost effective Best Management Practices (BMPs).

2. General Guidelines

General guidelines for erosion and sediment control are listed below. Sediment and erosion control plans must demonstrate consistency with these

guidelines.

< Minimize the area disturbed by construction at any given time.

< Stabilize disturbed areas as soon as possible by re-establishing sod, other forms of landscaping, and completing proposed structures, pavements, and permanent storm drainage systems.

< Provide for containment of sediment until areas are stabilized.

< Provide permanent erosion control by constructing and maintaining the permanent storm drainage system and maintaining vegetative cover, pavements, and other surface coverings in good condition.

< Avoid environmentally sensitive areas. Streams, springs, sinkholes, lakes, or wetlands are easily affected by sediment from construction sites. Careful planning and additional controls are needed when construction site are located in, or in close proximity, to these areas.

< Recognize sheet flow vs. concentrated flow. In areas where runoff occurs primarily as sheet flow, containment of sediment is relatively simple. In these areas, straw or hay bales, silt fences, and vegetative filter areas can be very effective. Where flow is concentrated, containment of sediment becomes more difficult as the rate and volume of flow increase. In these areas, more elaborate controls such as sedimentation basins must be provided.

< Recognize temporary vs. permanent controls. The greatest potential for soil erosion occurs during construction. Temporary controls are those which are provided for the purpose of controlling erosion and containing sediment until construction is complete. Temporary controls include straw or hay bale dikes, silt fences, erosion control blankets, etc., which are not needed after the area is stabilized. Permanent controls consist of vegetative cover, riprap, concrete trickle channels, detention basins, etc., which will remain in place through the life of the development. It is possible for the same feature to serve both a temporary and permanent purpose. The difference between temporary and permanent erosion control should be clearly recognized in preparing an erosion and sediment control plan.

3. Grading Permits

a. Grading Permit Requirements.

A Grading Permit must be obtained before any land is graded for non-agricultural purposes.

Grading is defined as any excavation or filling or combination thereof. Grading of agricultural land is considered non-agricultural whenever soil is excavated for sale off the site or soil from other properties is brought onto the site.

The City of Battlefield may waive the requirement for a Grading Permit in the following cases:

1. Sites where one (1) acre or less is graded, provided the graded area is located a distance of twenty-five feet (25') or more from a spring, sinkhole, cave, wetland, watercourse, or floodplain, and where the proposed construction does not include the construction of stormwater detention basins or other drainage facilities.

   NOTE: Lots in new subdivisions will be considered part of the entire subdivision site area.

2. The following activities, provided they are not located within twenty-five feet (25') of a spring, sinkhole, cave, wetland, or watercourse:

   a. Grading for single family residences.

      NOTE: Lot grading done as a part of an overall subdivision plan in order to make lots buildable or prepare lots for sale is not exempt.

   b. Grading and repair of existing roads or driveways.

   c. Cleaning and routine maintenance of roadside ditches or utilities.

   d. Utility construction where the width of the disturbed area for trench excavation and backfill is twenty feet (20') or less.

3. Emergency construction required to repair or replace roads, utilities, or other items affecting the general safety and well being of the public.

For emergency construction sites which would otherwise be required to obtain a permit and for which remedial construction will take more than fourteen (14) calendar days, application for the permit must be made within three (3) calendar days from the start of construction.

b. Permit Procedure

The following items must be submitted prior to issuance of a Grading Permit:

1. Completed grading permit application signed by the property owner or his legally authorized agent.

2. Grading permit fee.

3. An approved sediment and erosion control plan (SECP).

4. Performance bond or other required security.

5. For sites where five (5) acres or more of land are disturbed a copy of the Missouri State Operating Permit.

6. Other State or Federal permits, if required (see Section I.4).

c. The submittal and approval procedure is as follows:

1. Subdivisions

A sediment and erosion control plan (SECP) shall be submitted for review along with the plans for the subdivision improvements.

Grading permits for subdivisions can be issued after approval of the plans for the subdivision improvements by the City of Battlefield, and the items listed above are received.

2. Buildings

Two (2) copies of the sediment and erosion control plan (SECP) shall be submitted to the Building Regulations Department along with the building plans.

Grading permits can be issued after approval of the SECP and storm drainage plans by the City of Battlefield and the items listed above are received.

3. Other Sites

Other sites include borrow and spoil areas, gravel mining areas, and any other sites where a subdivision plat or a building permit is not required.

Two (2) copies of the sediment and erosion control plan (SECP) shall be submitted to the City of Battlefield for review.

A grading permit can be issued after approval of the SECP by the City of Battlefield and the items listed above are received.

c. Sediment & Erosion Control Plan (SECP)

1. Professional Qualifications

Sediment and Erosion Control plans must be prepared by and bear the seal of an engineer, land surveyor, architect, landscape architect, or geologist registered to practice in the State of Missouri or by a Certified Professional in Erosion and Sediment Control (CPESC) who has attained certification by the Soil & Water Conservation Society. When the total area of the site exceeds five (5) acres, or the drainage area of any watershed for which an element of the plan must be designed exceeds five (5) acres, the plan must be prepared under the supervision of an engineer registered in Missouri.

2. Plan Requirements

The sediment & erosion control plan must be drawn to scale and must include the following items:

a. Location map at a scale of 1" = 2000'.
b) Legal description of property.
c) North arrow and scale.
d) One-Call utility notification symbol.
e) Title block.
f) Signature block for City of Battlefield approval.
g) Design professional's seal.

h) Existing topographic contours at five feet (5') maximum intervals.
i) Proposed grades.
j) Existing and proposed utilities.
k) Existing ground covering (open areas, tree masses, etc.).
l) Existing buildings, drives and pavements.
m) Proposed buildings or other structures, drives, and pavements.
n) Limits of area to be disturbed (shading preferred).
o) Location of erosion and sediment controls.
p) Details of non-standard erosion and sediment controls.
q) Seeding & mulching requirements.
r) Total site area, total disturbed area.
s) Location of stockpile areas, staging areas, etc.
t) Location of temporary construction entrance.

d. Bond Requirements

1. Subdivisions

A security agreement or other form of security acceptable to the County in the amount of the value of the required sediment and erosion controls, including the storm drainage system, must be received prior to issuance of the grading permit.

2. Buildings

If the grading permit is issued prior to the building permit, the only type of bond accepted will be a cash bond. After issuance of the building permit, the cash bond can be converted to an escrow, security agreement, or other form of bond allowed.

3. Other Sites

Only cash bonds will be accepted for sites where a subdivision plat or building permit is not required. A cash bond is obtained by submitting the required bond amount to the City of Battlefield office in the form of cash, cashier's check or money order, and obtaining a receipt.

4. Amount of Security

The amount of security will be one thousand dollars ($1,000.00) per graded acre for seeding and mulching, plus the estimated construction cost for permanent sediment and erosion control measures specified on the SECP. This includes all elements of the storm drainage system.

5. Release of Bond

Bond will be released one (1) year after seeding and mulching is complete, provided vegetation is firmly established. If vegetation is not firmly established at this time, the bond will be forfeited and the work will be completed under the direction of the City.

Bonds may be released sooner if vegetation is firmly established. Vegetation will be considered firmly established when it has survived from the permanent seeding season in which it is placed to the next permanent seeding season and growth has been established on all eroded areas which have been noted for repair.

4. Other Permits

a. NPDES Stormwater Permit

When the area of land disturbance is five (5) acres or more, an application for a stormwater discharge permit must be submitted to the Missouri Department of Natural Resources. Permit requirements are set forth in 10 CSR 20-6.200 of the Missouri Clean Water Laws.

For sites requiring a State permit, the following procedure applies:

1. The applicant submits MDNR forms E and G, the MDNR fee (with check made payable to "Director of Revenue")

2. MDNR reviews the application
3. The sediment and erosion control plan is submitted to the City of Battlefield with a copy of the permit.

4. A City permit can be issued upon receipt of a copy of the State permit. Construction can commence only after issuance of the City grading permit.

b. "404" Permit

Grading activities in streams or wetlands may require a Department of the Army Permit under Section 404 of the Clean Water Act. It is the obligation of the property owner or operator to contact the Corps of Engineers to determine whether a permit is required whenever working in these areas. A copy of the Corps of Engineers written determination, where applicable, shall be provided prior to issuance of the grading permit.

5. Design Standards & Criteria

a. Grading

1. Maximum grades. Cut or fill slopes shall not exceed three (3) horizontal to one (1) vertical (3:1). 4:1 slopes are preferred where possible.

2. Maximum height. Cut or fill slopes shall not exceed fifteen feet (15') feet in vertical height unless a horizontal bench area at least five feet (5') in width is provided for each fifteen feet (15') in vertical height.

3. Minimum slope. Slope in grassed areas shall not be less than one percent (1%).

4. Construction Specifications. Construction of private and public streets must comply with specifications set forth.

For all other areas, construction specifications stating requirements for stripping, materials, subgrade compaction, placement of fills, moisture and density control, preparation, and maintenance of subgrade must be included or referenced on the plans or accompanying specifications.

5. Spoil Areas. Broken concrete, asphalt, and other spoil materials may not be buried in fills within proposed building or pavement areas.

Outside of proposed building and pavement areas, broken concrete, asphalt or stone may be buried in fills, provided it is covered by a minimum of two feet (2') of earth.

Burying of other materials in fills is prohibited.

6. Stockpile Areas. Location of proposed stockpile areas shall be outlined on the plans and specifications for proper drainage included.

7. Borrow Areas. The proposed limits of temporary borrow areas shall be outlined in the plans and a proposed operating plan described on the SECP.

   At the time borrow operations are completed, the area shall be graded in accordance with the criteria set forth above and vegetation re-established.

b. Sediment Control

1. Existing Vegetative Filter Area. Existing vegetative filter areas may be used where:

   a. unconcentrated sheet flow occurs,

   b. an area of existing vegetation a minimum of twenty-five feet (25') in width can be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland, or waterbody,

   c. existing ground slope is no greater than five to one (5:1) or twenty percent (20%),

   d. the existing vegetative growth is of sufficient density and in sufficiently good condition to provide for filtration of sediment.

   The minimum width of the vegetative filter area shall be twenty percent (20%) of the width of the tributary area. Vegetative filter areas can be used as both a temporary and permanent practice.

2. Straw bale dike or silt fence. Containment areas constructed of hay or straw bales or silt fence may be provided in areas where:

   a. unconcentrated sheet flow occurs.

b. an area of existing vegetation a minimum of twenty-five feet (25') in width cannot be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland, or classified lake.

c. the maximum width of cleared area upslope of the bale dike or silt fence is as set forth below:

Slope of cleared area (%)	Maximum width upslope of dike/silt fence (feet)
2 to 5	100
5 to 20	50
> 20	25

Either cereal grain straw or hay may be used for bale dikes. Straw bale dikes shall be constructed as shown in Figure SS-I1.

Silt fence may be used in lieu of hay or straw bales. Silt fence shall be constructed as shown in Figure SS-I2.

Straw bale dikes must be installed level, that is, "along the contour", in order to avoid creating points of concentrated overflow. Straw/hay bale dikes and silt fences must be periodically inspected and replaced as necessary if deteriorated.

Hay bale dikes and silt fences are temporary practices.

3. Temporary Containment Berm. Temporary containment berms may be used in lieu of straw bale dikes or silt fence, under the same conditions set forth above. An overflow area six inches (6") below the top of the berm and five feet (5') in length or an approved alternative must be provided for each two hundred feet (200') of berm length. The overflow area shall be lined with six (6) mil or thicker polyethylene plastic, six (6) ounces or heavier non-woven filter fabric, or other approved lining. Plastic and fabric liners shall be held in place by covering the perimeter with earth or weighting down with large rock or sandbags.

Containment berms and swales must be installed level, "along

the contour".

Accumulated sediment must be removed when it reaches one-third (1/3) of the berm height.

Temporary containment berms and accumulated sediment must be completely removed after the tributary area is stabilized.

Temporary containment berms shall be constructed as shown in Figure SS-I3.

4. Inlet Protection. This practice consists of protecting the inlet perimeter or opening with straw bales, silt fence or sandbags. The purpose of this practice is to keep sediment from collecting in storm drains. This practice is also useful when site conditions prevent locating a sediment basin downstream of the storm sewer outfall.

NOTE: Inlet protection described in this paragraph cannot be used where blockage of the inlet opening would result in flooding of residential dwellings, buildings, streets or roads, or off-site property.

a. Curb Inlets

Curb inlets can be protected from sediment entry by placing sand bags over the inlet opening. Sand bags must be replaced when deteriorated and removed when the area has been stabilized. Curb inlet protection is shown in Figure SS-I4.

Accumulated sediment must be removed from the street after each rainfall.

b. Area Inlets

In paved areas, area inlets can be protected by placing gravel filled sandbags up to two (2) courses high around the perimeter of the inlet.

Outside of paved areas or before pavement is placed, area inlets can be protected by installing a silt fence of straw bale dike around the inlet perimeter.

Type DI-1 inlets can be protected by placing sandbags over the openings.

Accumulated sediment must be removed prior to final approval.

Area inlet protection is shown in Figure SS-I4.

5. Diversion. Where flow must be diverted into sediment basins or other sediment retaining facilities, diversion berms or swales or other approved means of diverting runoff may be specified.

Where sediment enters a street which is up-grade from an existing street, means must be provided to divert runoff to a sediment basin before discharge from the site. The method of diversion will vary depending upon the phase of construction. After initial grading, an earth berm can be used. This is no longer possible after the street subgrade is completed and curbs are installed. After the street pavement is completed, sand bags can be used to divert the runoff into inlets for discharge into the sediment basin. Diversion of street runoff is shown in Figures SS-I5 and SS-I6.

6. Gravel Filter Dam

Where concentrated flow occurs and less than two (2) acres of tributary drainage area are graded (i.e. a sediment basin is not required) or where construction of a sediment basin is not feasible, a gravel filter dam shall be provided prior to discharge of runoff from the property.

Gravel filter dams consist of a layer of filter fabric and crushed rock covering the upstream side of a riprap dike. Riprap shall be six and twelve inches (6"and12") in size. Filter fabric may be woven or non-woven, Mirafi 500X, Mirafi 150NL, or equal. The purpose of the filter fabric is to remove sediment particles as water flows through it. The layer of crushed rock provides additional filtration protects the filter fabric, and holds it in place.

Where gravel filter dams are used as sediment basin outlets, one (1) square foot of filter fabric area shall be provided for each one thousand (1,000) cubic feet of storage. The minimum

area provided shall be four (4) square feet.

Where gravel filter dams are used as ditch checks in channels, the gravel filter area shall extend throughout the width of the dam.

Riprap stilling basins shall be provided downstream of the filter dam where discharge is to a grass channel.

Gravel filter dam details are shown in Figures SS-I7A and SS-I7B.

7. Sediment Basin

Sediment basins shall be provided for all areas where concentrated flow occurs from an area of five (5) or more acres and vegetative cover has been stripped from more than two (2) acres. Sediment basins shall be designed to detain the first one-half inch (½") of runoff from the graded area for a period of at least twenty-four (24) hours (approximately two thousand (2,000) cubic feet per acre graded).

Sediment basins shall have an outflow control structure capable of providing the required detention time. Outflow control structures shall consist of a gravel filter dam meeting the requirements of Section I.5.b.6, or a perforated riser pipe.

Sediment basins shall also be provided with an overflow structure capable of passing the peak flow rate for storms up to and including the 10% AEP (10-year) storm. The required sediment control volume shall be provided below the elevation of the overflow structure. One foot (1') of freeboard shall be maintained over the 10-year high water elevation.

Perforated riser pipes shall have a minimum diameter of eight inches (8") and shall be constructed of schedule SDR35 or stronger PVC pipe, galvanized corrugated metal pipe, or other approved pipe material. Riser pipes must be provided with a cap. Plans shall specify the height of the riser pipe above the basin floor, the number and spacing of rows of perforations, and the number and diameter of perforations per row. One and one-half inch (1 ½ ") crushed rock shall be placed around the

riser pipes to act as a filter. A typical riser pipe detail is shown in Figure SS-I10.

Outlet pipes shall have a minimum diameter of eight inches (8") and may be constructed of corrugated polyethylene pipe, corrugated metal pipe, SDR 35 or stronger PVC or reinforced concrete pipe.

Overflow spillways must be constructed of riprap, concrete or other approved, non-erodible material.

Typical sediment basin details are shown in Figures SS-I08, SS-I09 and SS-I10.

Sedimentation basins can be provided as temporary or permanent practices and can also serve as a permanent water quality BMP with appropriate design modifications to meet the criteria set forth in Section J.

Detention ponds can be used for temporary sediment basins, provided it can be demonstrated that flood control requirements can be met as well as sediment control requirements.

Accumulated sediment must be removed and vegetation established prior to final release of security.

c. Erosion Protection

1. Seeding and mulching. All disturbed areas must be re-vegetated before temporary sediment controls can be removed. Requirements for re-vegetated areas are as follows:

a. Topsoil. Spreading of topsoil is required for permanent seeding areas only. Topsoil stripped from the site shall be stockpiled for reuse. A minimum of four inches (4") loose depth (before rolling or compacting) of topsoil must be spread on the area to be seeded.

b. Lime. After topsoil is spread, lime shall be spread at the rate of eight hundred to nine hundred (800 to 900) pounds effective neutralizing material (ENM) per acre.

c. Fertilizer. Fertilizer shall be 13-13-13, (thirteen (13) pounds each of nitrogen, phosphorus, and potassium per one hundred (100) pounds) and shall be applied at a rate of four hundred to five hundred (400 to 500) pounds per acre.

d. Seed. Seed mix shall consist of sixty percent to eighty percent (60% to 80%) Kentucky 31 tall fescue and twenty percent to forty percent (20% to 40%) annual ryegrass. Purity shall be at least ninety-seven percent (97%), germination shall be at least eighty-five percent (85%). Seed mixture shall be applied at a rate of four hundred to five hundred (400 to 500) pounds per acre.

e. Mulch.

1. Type 1 Mulch. Where slopes are less than 4:1, cereal grain mulch is required at the rate of one hundred (100) pounds per one thousand (1,000) square feet (forty-five hundred (4,500) pounds per acre). Cereal grain mulch shall meet the requirements of Section 802 of the Missouri State Specifications for Highway Construction (State specifications) for Type 1 mulch. Mulch may be applied by hand, however it must be evenly spread. It is preferred that mulch be applied with a mechanical blower.

   Type 1 mulch must be thoroughly wetted after application.

2. Type 3 Mulch. Where slopes are 4:1 or greater Type 3 mulch ("hydromulch") meeting the requirements of Section 802 of the State specifications. Type 3 mulch shall be applied at a minimum rate of two thousand (2,000) pounds per acre.

f. Permanent seeding season. Permanent seeding seasons run from March 1 to June 1 and from August 15 to November 1. Where possible, operations shall be scheduled to allow final seeding during these periods. When seeding cannot be completed during these times,

areas shall be seeded and mulched upon completion of grading with the amounts of lime, fertilizer, seed, and mulch specified above, regardless of the season. Any areas where growth has not been established shall be re-seeded during the next seeding season.

g. Temporary seeding. Temporary seeding shall be applied to lot areas, building areas and other areas planned to receive other permanent coverings. Spreading of topsoil is not required in temporary seeding areas. Lime, fertilizer, seed, and mulch shall be applied at the rates specified above.

h. Maintenance. Areas seeded between March 1 - June 1 or between August 15 - November 1 must be maintained until growth is firmly established as set forth in Section I.3.d.5.

i. Other specifications. Other seeding and mulching specifications may be used with the written approval of the City of Battlefield.

2. Cut and Fill Slopes. Cut and fill slopes shall be protected from erosion by construction of straw bale dikes, silt fences, diversion berms, or swales along the top of the slope.

Where drainage must be carried down the slopes, pipe drains, concrete flumes, riprap chutes, or other impervious areas must be provided. Suitable erosion control measures such as riprap stilling basins, must be provided at the bottom of the slope.

Diversions shall be maintained until permanent growth is firmly established on the slopes.

Typical diversion details are shown in Figure SS-I11. Riprap chute details are shown in Figure SS-I12.

3. Channels and Swales. Permanent channels and swales shall be provided with a stabilized invert, as provided in Section G.

4. Storm Sewer and Culvert Outlets. Erosion protection shall be provided at storm sewer and culvert outlets as provided in Sections F.4.

5. Ditch Checks. Straw bale ditch checks have proven to be generally ineffective due to improper installation and inability of bales to withstand the force of concentrated flow of water. Ditches, channels, and swales should be stabilized as soon as possible after grading by lining with erosion control blanket, sod, or installing permanent linings as described in Section G.

   Where ditches, channels, or swales cannot be stabilized within thirty (30) days after grading, rock check dams or sand bag check dams must be provided. Rock check dams may be used in ditches with a design water depth of up to two feet (2') for the 2-year storm. Sand bag check dams may be used in ditches with a design water depth of up to one foot (1') for the 2-year storm.

   Rock check dams are shown in Figure SS-I13. Sand bag check dams are shown in Figure SS-I14.

d. Temporary Construction Entrance

A minimum of one (1) temporary construction entrance is required at each site. Additional temporary entrances may be provided if approved. The location of each construction entrance shall be shown on the SECP.

Only construction entrances designated on the sediment and erosion control plan may be used. Barricades shall be maintained if necessary to prevent access at other points until construction is complete.

Construction entrances shall be constructed of one and one-half inches (1 ½") clean crushed limestone and shall be a minimum of twenty-five feet (25') wide and fifty (50') feet long. Minimum thickness of crushed limestone surface shall be six inches (6"). Additional two inch (2") lifts of crushed limestone shall be added at the discretion of the City if the surface of the initial drive deteriorates or becomes too muddy to be effective.

In locations where an existing drive or street extends at least fifty feet (50') into the site, the existing drive may be designated as the construction entrance, and construction of a new gravel entrance is not required, unless job conditions warrant.

A permit must be obtained from the Greene County Highway

Department for temporary construction entrances on County roads. A permit must be obtained from the Missouri Department of Transportation (MODOT) whenever the entrance is located on State right-of-way.

e. Cleaning Streets

Streets, both interior and adjacent to the site, shall be cleaned of sediment after each rainfall of one-half inch (½") or more and at the end of construction and prior to release of escrow.

f. Dust Control

The contractor will be required to use water trucks to wet haul roads and construction areas to minimize dust leaving the site when conditions warrant.

g. Sequencing and Scheduling

Costs of sediment and erosion control can be minimized if proper consideration is given to sequencing and scheduling construction.

Any special sequencing and scheduling considerations must be noted on the SECP.

J. WATER QUALITY PROTECTION

1. Purpose. This section covers the design of Best Management Practices (BMPs) to minimize the adverse effects of urban stormwater runoff on the quality of receiving waters.

The requirements of this section will apply to all new developments that drain into sinkholes.

As the role which urban runoff from the Springfield metropolitan area plays in the quality of the James River and Table Rock Lake becomes better understood, it is anticipated that water quality requirements will be extended to watersheds of the James River and its tributaries.

It is recognized that specific water quality standards, other than those contained in the Missouri Clean Water Laws, have not been developed or adopted for these receiving waters. The objective of this policy is not to meet specific reductions of targeted pollutants, but rather to provide a generally

effective level of pollutant removal by using reasonable, cost effective measures. The goal is to minimize, to the maximum extent practical, adverse impacts on the quality of the receiving waters.

2. General Design Guidelines

a. Minimize the amount of runoff.

The total quantity of pollutants transported to receiving waters can be minimized most effectively by minimizing the amount of runoff. Both the quantity of runoff and the amount of pollutant wash-off can be minimized by reducing the amount of *directly connected impervious area (DCIA)*. Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Impervious areas are considered disconnected when runoff passes as sheet flow over grass areas, or through properly designed BMP's, prior to discharge from the site.

b. Maximize contact with grass and soil.

The opportunity for pollutants to settle out is maximized by providing maximum contact with grass and soil. Directing runoff over vegetative filter strips and grass swales enhances settling of pollutants as the velocity of flow is reduced. Infiltration of runoff into the soil is also increased.

c. Maximize holding and settling time.

According to ASCE, the most effective runoff quality controls reduce the runoff peak and volume. The next most effective controls reduce peak runoff rates only. For small storms the runoff rate should not exceed the pre-project peak flow rate from the fifty percent (50%) AEP (2-year) storm. Most obnoxious pollutants (exceptions include water soluble nutrients and metals) can be settled out.

By reducing the rate of outflow and increasing the time of detention storage, settling of pollutants and infiltration of runoff is maximized.

d. Design for small, frequent storms.

Drainage systems for *flood control* are designed for large, infrequent storm events. In contrast, stormwater quality controls must be

designed for small, frequent storm events. In Greene County ninety percent (90%) of all twenty-four (24) hour rainfalls are one inch (1") or less. Most pollutants are washed off in the "first flush", generally considered the first one-half inch (½") of runoff.

e. Utilize BMP's in series where possible.

Performance monitoring of BMP's in Florida, Maryland, and Delaware has shown that the combined effect of providing several BMP's in a series can be much more effective in reducing the level of pollutants than providing a single BMP at the point of discharge. To the greatest extent practical, runoff should be directed first to vegetative filter strips, then to grass swales or channels, and then to extended detention basins, sand filters, etc.

f. Incorporate both flood control and water quality objectives in designs, where practical.

Incorporating both flood control and water quality criteria into a single stormwater management facility is not only possible, but is encouraged. Whenever practical, combining several objectives, such as water quality enhancement and flood control, maximizes the cost-effectiveness of stormwater management facilities.

3. Requirements. The following requirements will apply to any new development within sinkhole drainage areas:

a. Stormwater runoff from any new development for which the total impervious area exceeds ten percent (10%) of the total land area of the development, must be directed through an extended wet or dry detention basin, or other properly designed BMP, prior to discharge from the site.

b. Runoff from fueling areas and other areas having a high concentration of pollutants will be required to be directed to a sand filter or other properly designed BMP which provides filtration as well as settling.

c. The required volume for capture and treatment shall be designed as the *water quality capture volume* (WQCV), and shall be determined as set forth in Section J.4.a.

d. Detention storage must be provided to limit the peak flow rate from the fifty percent (50%) AEP (2-year) storm to pre-project values.

Detention facilities for peak flow control shall be designed as set forth in Section H.

4. Design Criteria

a. Water Quality Capture Volume

Water quality BMPs shall be designed to capture the runoff from the 90th percentile rainfall for Greene County as well as to capture the first flush of pollutants from directly connected impervious areas within the proposed development.

The required water quality capture volume (WQCV) to be used in design of extended wet and dry detention basins and other BMPs whose design is based upon capture and treatment of storm water, shall be the greater of the following:

1) the first one-half inch (½") of runoff from the directly connected impervious area (DCIA) in the development, or

2) the *runoff* resulting from total rainfall depth of one inch (1") in twenty-four (24) hours over the entire development.

b. Directly Connected Impervious Area (DCIA)

Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Connected and disconnected impervious areas are illustrated in Figure SS-J1.

In order for an impervious area to be considered disconnected, runoff from the area must pass through a vegetative filter strip or other BMP meeting the requirements set forth in this section.

For determining the amount of impervious area , the following assumptions shall apply in the absence of more detailed data:

Single Family Lots

Average roof area:	2500 square feet
Average drive area:	800 square feet
Average impervious area per lot:	3500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Duplexes and Patio Homes

Average roof area:	2500 square feet
Average drive area:	1600 square feet
Average impervious area per lot:	4500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Multi-Family,Commercial and Other Areas

The amount of impervious area contained in multi-family, commercial, office and manufacturing developments shall be determined based upon the site plan for the development.

c. Vegetative Filter Strips

Vegetative filter strips consist either of areas of undisturbed vegetation in good condition, including trees, grass, sod or other vegetative cover which meets the objectives for this BMP, or areas where new vegetation has been established. Vegetative filter strips shall be provided in areas of sheet flow only. The hydraulic loading for filter strips shall not exceed 0.05 cfs per lineal foot of filter strip length for the fifty percent (50%) AEP (2-year) storm (equal to the runoff per unit width from a four hundred feet (400') length of impervious area).

The minimum width of the filter strip shall not be less than twenty percent (20%) of the length of the sheet flow from the upstream impervious surface, and in no case shall be less than six feet (6'). The slope along the width of the filter strip shall not exceed 4:1 (25%).

Typical details for vegetative filter strips are shown in Figure SS-J2.

d. Grass Swales

Grass swales may be provided to convey runoff from vegetative filter strips and impervious areas to BMP's designed for capture and temporary storage of runoff. Design criteria for grass swales shall be as follows:

1. Maximum side slopes: 4:1.

2. Maximum longitudinal slope: 5%.

3. Minimum longitudinal slope: 1%.

4. Maximum velocity: 2 feet per second for peak flow from the 50% AEP (2-year) storm.

Roughness coefficients for use in the design of grass swales shall be determined as set forth in Section G.4.b.

Grass swales shall be lined with sod or seeded and covered with suitable erosion control blanket and mulch.

Typical details for grass swales are shown in Figure SS-J3.

e. Extended Dry Detention Basins

Extended dry detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended dry detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., "off-line") where possible.

Design criteria for extended dry detention basins shall be as follows:

1. Volume: Minimum volume shall be one hundred and twenty-five percent (125%) of the required water quality capture volume (WQCV). Detention basins for water quality may be combined with detention basins for flood control. Effects of the WQCV may be considered in the design for flood control.

2. Drain time: The WQCV shall be released over a minimum period of forty (40) hours and a maximum period of seventy-two (72) hours.

3. Outlet structure: Outlet structures shall consist of a perforated riser pipe, outlet pipe and gravel filter material as shown in Figures SS-J4 and SS-J5. The minimum allowable riser pipe diameter is eight inches (8"). The riser pipe shall be connected to an outlet pipe of equal of greater diameter. The outlet pipe shall have adequate capacity to carry the maximum rate of flow from the riser pipe. Material for the riser pipe shall be Schedule 40 PVC, ductile iron, or corrugated, galvanized metal.

   A removable cap shall be provided at the top of the riser pipe. The cap shall have a one inch (1") diameter hole for air relief.

   The outlet pipe shall be bedded in firmly compacted clay, free of stones. For dams exceeding ten feet (10') in height, an anti-seep collar shall be provided around the pipe.

   Number of rows of perforations, number of perforations per row and diameter of perforations for the riser pipe shall be specified on the plans. Perforation pattern shall be determined based upon orifice calculations to provide for release of the WQCV over the specified time. Perforations shall meet the following requirements:

Minimum perforation diameter:	1/4 inch
Maximum perforation diameter:	1 inch

Minimum number of holes per row: 4
Maximum number of holes per row: 8

Minimum row spacing: 4 inches
Maximum row spacing: 12 inches

4. Freeboard: Where the basin is to be utilized as a water quality BMP only, twelve inches (12") minimum freeboard shall be provided above the WCQV.

5. Forebay: It is preferred that a forebay be provided to dissipate energy from incoming flows and to trap settleable sediment entering the basin. The forebay should be separated from the remainder of the basin by an earth dike meeting the requirements of Section H.6.b. The top of the dike shall be set six inches (6") above the stage of the WQCV. Outflow from the forebay to the basin shall be through a gravel filter meeting the requirements of Section I.5.b (Figure SS-I07A). The top of the gravel filter shall be set equal to the stage of the WQCV.

   The volume of the forebay shall be a minimum of ten percent (10%) and a maximum of twenty percent (20%) of the WQCV. The volume of the forebay is considered to be part of the required WQCV, not additional volume.

6. General construction requirements: The optimal length to width ratio for a water quality detention basin is four (4). The length to width ratio should be no less than two (2). The minimum allowable length to width ratio is one (1). Side slopes, dams or dikes, and retaining walls shall meet the requirements of Section H.6.

7. Overflow spillways: Where the basin is to be utilized as a water quality BMP only, a spillway or outlet structure meeting the requirements of Section H.6.e and capable of passing the peak flow from a 1% AEP (100-year) storm for the drainage area upstream of the basin, shall be provided. The lowest point on the spillway or outlet structure shall be set at the top of the WCQV.

8. Trickle channels: Trickle channels shall be provided to provide grade control and to minimize chronic wet areas. Trickle

channels shall be constructed of six inch (6") stone or other porous medium. A typical trickle channel cross section is shown in Figure SS-J6.

A typical plan and section for extended dry detention basins are shown in Figure SS-J7.

f. Extended Wet Detention Basins

Extended wet detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended wet detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., “off-line”) where possible.

Design criteria for extended wet detention basins shall be the same as for extended dry detention basins, with the following exceptions:

The volume of the permanent pool should not be less than 1.0 to 1.5 times the WQCV.

A bench area (littoral zone) with a width of ten feet (10') shall be provided as shown in Figure SS-J8. It is preferred that emergent aquatic vegetation be provided in this zone.

It is recommended that a minimum of twenty-five percent (25%) of the WQCV be provided in the upper eighteen inches (18") of depth. A maximum of fifty percent (50%) of the permanent pool volume shall be provided in the upper eighteen inches (18") of depth.

Depth of the principal portion of the permanent pool shall be a minimum of four feet (4').

It is preferred that a forebay meeting the same requirements as specified for dry detention basins, be provided.

Where perforated riser pipes are not encased in gravel, only corrugated metal or ductile iron pipe may be used.

Typical details for extended wet detention basins are shown in Figure SS-J8.

g. Sand Filters

Runoff from fueling plazas, vehicle maintenance areas, solid waste storage or transfer areas, and other areas having potentially high concentrations of contaminants shall be passed through a sand filter prior to discharge to receiving waters.

Total impervious area draining to a sand filter will generally be one (1) acre or less. Sand filters shall be provided with a sedimentation chamber and a filtration chamber. Design of sand filters shall be based upon the Austin, Texas first flush filtration basin (full sedimentation design) as described in Debo and Reese pp. 596-598. A schematic cross section of a sand filter is shown in Figure SS-J9.

h. Other Structural BMPs

Constructed wetlands, porous pavements and other structural BMPs for which detailed design criteria can be documented in generally accepted literature can be provided in addition to, or in lieu of, the BMPs described above, provided the objectives of this section can be met. The use of infiltration basins and trenches is discouraged due to possible adverse impacts on groundwater.

5. Operation and Maintenance. City of Battlefield provides no maintenance of water quality BMPs located on private property. Maintenance must be provided by the owner of the property upon which the BMP is located.

Extended detention basins and wetlands or other "capture and storage" BMPs shall be located within a single lot or property, within a designated drainage easement. Where BMPs are located in common areas or adjoining off-site areas, the property upon which the BMP is located shall remain in the ownership of the developer or property owners' association.

Where a property owners' association is formed, restrictive covenants which provide for collection of fees for maintenance of the BMPs shall be filed in the office of the Greene County Recorder of Deeds. Restrictive covenants must be approved by the City legal counselor prior to filing of the final plat.

Table C.1

MONTHLY & ANNUAL
PRECIPITATION AND EVAPORATION DATA

Greene County, Missouri, Average Precipitation and Evaporation. Source: National Weather Climatological Data Annual Summary, Missouri 1995.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July
Precipitation	1.79	2.17	3.89	4.18	4.38	5.09	2.92
Evaporation	0.30	0.50	2.80	4.30	5.00	6.00	6.80
Precipitation - Evaporation	1.49	1.67	1.09	- 0.12	- 0.62	- 0.91	- 3.88

Month	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Precipitation	3.51	4.62	3.58	3.75	3.16	43.04
Evaporation	6.20	4.00	3.00	2.70	0.40	42.00
Precipitation - Evaporation	- 2.69	0.62	0.58	1.05	2.76	1.04

Table C.2

RAINFALL DEPTH & DURATION DATA

Greene County, Missouri

Duration	**Rainfall Intensity, Inches/Hour**					
Minutes	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
5	5.40	6.48	7.23	8.40	9.30	10.20
6	5.19	6.21	6.99	8.08	8.82	9.82
7	4.99	5.98	6.70	7.78	8.60	9.46
8	4.80	5.75	6.46	7.50	8.30	9.10
9	4.60	5.54	6.22	7.22	8.01	8.78
10	4.42	5.34	6.00	6.97	7.71	8.46
11	4.29	5.16	5.79	6.71	7.44	8.16
12	4.13	4.98	5.58	6.48	7.18	7.88
13	4.00	4.81	5.40	6.27	6.94	7.62
14	3.88	4.78	5.24	6.08	6.83	7.40
15	3.75	4.53	5.10	5.91	6.55	7.20
16	3.66	4.42	4.98	5.78	6.41	7.03
17	3.56	4.31	4.86	5.65	6.27	6.89
18	3.48	4.21	4.75	5.53	6.13	6.75
19	3.40	4.13	4.66	5.42	6.02	6.62
20	3.32	4.04	4.56	5.32	5.91	6.51
25	3.00	3.78	4.17	4.89	5.44	5.99
30	2.72	3.38	3.84	4.52	5.03	5.56
35	2.51	3.13	3.57	4.20	4.70	5.18
40	2.32	2.91	3.32	3.92	4.39	4.84
45	2.16	2.71	3.11	3.68	4.11	4.54
50	2.01	2.52	2.91	3.44	3.85	4.26
55	1.88	2.39	2.74	3.23	3.62	4.02
60	1.80	2.28	2.61	3.08	3.44	3.80

Duration	**Rainfall Depth, Inches**					
Minutes	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
15	0.94	1.13	1.28	1.48	1.64	1.80
20	1.11	1.35	1.52	1.77	1.97	2.17
25	1.25	1.58	1.74	2.04	2.27	2.50
30	1.36	1.69	1.92	2.26	2.52	2.78
35	1.46	1.83	2.08	2.45	2.74	3.02
40	1.55	1.94	2.21	2.61	2.93	3.23
45	1.62	2.03	2.33	2.76	3.08	3.41
50	1.68	2.10	2.43	2.87	3.21	3.55
55	1.72	2.19	2.51	2.96	3.32	3.69

Duration	**Rainfall Depth, Inches**					
Hours	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	1.80	2.28	2.61	3.08	3.44	3.80
2	2.22	2.80	3.21	3.80	4.25	4.75
3	2.45	3.10	3.60	4.25	4.68	5.25
6	2.84	3.72	4.25	5.00	5.50	6.05
12	3.30	4.27	4.82	5.75	6.30	7.05
24	3.90	4.90	5.65	6.78	7.45	8.00
48	4.20	5.25	6.05	7.10	8.00	8.95
72	4.65	5.90	6.75	7.80	8.80	10.00
120	5.25	6.50	7.50	8.60	9.65	11.00
240	6.70	8.10	9.20	10.50	11.65	12.80

Source: "Five-to 60-Minute Precipitation Frequency for the Eastern and Central United States", National Weather Service, 1977. "Rainfall Frequency Atlas of the Midwest", Midwestern Climate Center, 1992.

TABLE C.3

RUNOFF COEFFICIENTS FOR USE IN THE RATIONAL FORMULA

Surface Type	Runoff Coefficient	Notes
Asphalt, concrete pavement	0.95	(1,3)
Roofs	0.95	(1,3)
Gravel	0.70	(2,3)
Lawns, pasture, hayfields		
Flat (<2% slopes)	0.15	(1,3)
Average (2-7% slopes)	0.20	(1,3)
Steep (>7% slopes)	0.30	(1,3)
Woods	0.10	(2,3)

COMPOSITE RUNOFF COEFFICIENTS FOR SINGLE FAMILY RESIDENTIAL AREAS
(using recommended values for runoff coefficients and estimates of impervious area given in this table)

	Terrain		
	Flat	Average	Steep
Avg. Lot size, 1/4 acre	0.45	0.49	0.55
Avg. Lot size, 1/3 acre	0.40	0.43	0.50
Avg. Lot size, ½ acre	0.35	0.40	0.46
Avg. Lot size, 1 acre	0.25	0.30	0.38
Avg. Lot size, 3 acres	0.20	0.24	0.33

IMPERVIOUS COVERAGE FOR TYPICAL DEVELOPMENTS
FOR USE IN COMPUTING COMPOSITE RUNOFF COEFFICIENTS

Type of Development	Zoning District	% Impervious Cover
Single Family Residential		
Avg. Lot size, 1/4 acre	R1	38 (Note 5)
Avg. Lot size, 1/3 acre	R1	30 (Note 5)
Avg. Lot size, 1/2 acre	R1	25 (Note 5)
Avg. Lot size, 1 acre	R1	13
Avg. Lot size, 3 acres	A-R	5
Duplex, patio homes	R2	(Note 6)
Multifamily	R3	(Note 7)
Office	O1, O2	(Note 7)
Commercial	C1, C2	70 (Note 8)
Commercial	C3	60 (Note 8)
Industrial, Manufacturing	M1, M2	(Note 7)

(***NOTES FOR TABLE C.3 ON NEXT PAGE***)

NOTES FOR TABLE C.3:

(1) From ASCE Manual of Practice, Table 5.5, p. 91. (Reference 104.13)
(2) From Ritter & Paquette, Highway Engineering, as referenced in The Rational Method Revisited, by Ronald L. Rosmiller, Poceedings of the International Symposium on Urban Runoff, University of Kentucky, Lexington, KY, June 28-31, 1980.
(3) Each of the above references suggests a range of values for each type of cover. The values given in this table reflect prevailing local practice.
(4) The ASCE manual of practice (Reference 104.13) notes that the normal range of runoff coefficients given in the manual are typical for return periods of 2 to 10 years. Because infiltration and other losses have a proportionately less effect, higher values are recommended for storms with larger return periods. Debo and Reese recommend increasing runoff coefficients by 10% for a 25-year return period and 25% for a 100-year return period (maximum value of 1.0). (Reference 104.14)
(5) Values from SCS TR-55 Table 2-2a. (Reference 104.5)
(6) Typical value used locally.
(7) % impervious area should be determined on a case by case basis from the site plan.
(8) Maximum impervious area coverage permitted by the Zoning Code for this district.

TABLE C.4
HYDROLOGIC SOIL GROUPS FOR GREENE COUNTY SOILS

MAP SYMBOL	NAME	HYDROLOGIC GROUP
1B	Newtonia silt loam	B
2B	Pembroke silt loam	B
3D	Eldon cherty silt loam	B
5C	Wilderness cherty silt loam	C
6B	Creldon silt loam	C
9B	Needleye silte loam	C
10	Bado silt loam	D
11B	Sampsel silty clay loam	D
16B	Barco fine sandy loam	B
21B	Peridge silt loam	B
23B	Bolivar fine sandy loam	B
24	Parsons silt loam	D
26D	Collinsville fine sandy loam	D
27D	Basehor stony fine sandy loam	D
30C	Keeno cherty silt loam	C
32C	Freeburg & Alsup silt loams	C
33B	Keeno & Eldon cherty silt loams	60%C/40%B*
35D	Clarksville-Nixa cherty silt loam	75%B/25%C*
40E	Alsup very stony silt loam	C
43D	Goss cherty silt loam	B
44E	Goss-Gasconade complex	80%B/20%D*
45E	Clarksville cherty silt loam	B
50C	Nixa cherty silt loam	C
53B	Wilderness & Goss cherty silt loam	60%C/40%B*
54	Lanton silt loam	D
55	Huntington silt loam	B
56	Osage silty clay loam	D
61B	Hoberg silt loam	C
76	Hepler silt loam	C
81B	Viraton silt loam	C
83D	Gasconade-rock outcrop complex	D
94	Cedargap cherty silt loam	B
95	Cedargap silt loam	B
240	Gerald silt loam	D
241B	Parsons & Sampsel silt loams	D
245	Carytown silt loam	D
921	Secesh-Cedargap silt loams	B
931	Waben-Cedargap silt loams	B

* Based on relative percent of each soil given in the Soil Survey.

TABLE C.5

Pilgrim-Cordery Method
Cumulative Depth vs. Duration Data

Cumulative Fraction of Storm Duration	Cumulative Fraction of Depth 1-Hour	2-Hour	3-Hour	4-Hour	6-Hour
.00	.00	.00	.00	.00	.00
.05	.03	.03	.03	.02	.05
.10	.07	.05	.05	.03	.09
.15	.11	.10	.06	.05	.14
.20	.14	.17	.09	.06	.20
.25	.17	.22	.11	.08	.28
.30	.23	.25	.13	.14	.35
.35	.29	.27	.19	.20	.41
.40	.35	.29	.31	.27	.43
.45	.41	.30	.39	.33	.46
.50	.47	.31	.44	.38	.49
.55	.56	.41	.47	.47	.60
.60	.65	.51	.54	.56	.70
.65	.73	.60	.64	.64	.80
.70	.82	.69	.70	.74	.86
.75	.91	.78	.73	.83	.89
.80	.93	.82	.81	.87	.93
.85	.95	.87	.89	.90	.96
.90	.97	.92	.94	.93	.97
.95	.99	.96	.98	.97	.98
1.00	1.00	1.00	1.00	1.00	1.00

CHAPTER 3 - STREETS, SIDEWALKS & DRIVEWAYS

A. STREETS

1. Street Construction. City streets shall be constructed of Portland Cement Concrete with integral curb (or concrete curb and gutter) or bituminous plant mix roadway with a concrete curb and gutter. Alley pavement shall be of either asphalt or concrete design, with an inverted crown and the curb omitted. Asphaltic streets will require bituminous or "full depth" asphalt base.

2. Roadway Sections. Typical roadway sections showing various widths of roadway and right-of-way and required thickness are as shown on Standard Drawing ST-1 included in these design standards. Primary arterials and expressways are not included in these design standards since such projects require individual study.

3. Street Design. In the preparation of street design, the following criteria must be observed. These controls are intended to be the absolute minimum (or maximum) permitted. Where two of the controls, a through e, are used concurrently in a street segment, the remaining controls, a through e, cannot be the minimum (or maximum) value. Any design not meeting this requirement must have prior approval. Road classification greater than those listed will require a special design to meet current AASHTO Standards.

a. Grades

- minimum	All Systems	0.5%
- maximum	Second arterial	5%
	Collector (Residential and Non Residential)	8%
	Local (Residential and Non Residential)	10%
	Alleys	10%

b. Vertical Curves. The length of vertical curves shall be no less than that determined by the formula

L = KA, where:

L = Length of vertical curve

A = Algebraic difference in grades

K = Determined by following table:

Table of "K" Values

	Crest	Sag
Secondary Arterial	80	70
Collector		
Non-Residential	60	60
Collector		
Residential	40	50
Local		
Non-Residential	30	40
Local		
Residential	20	30
Alleys	10	20

c. Minimum centerline radii (R) and Maximum superelevation (E)

Secondary Arterial	R = 600'	E = 0.04
Collector (Residential and		
Non-Residential)	R = 400'	E = 0.03
Local		
Non-Residential	R = 300'	E = 0.02
Local		
Residential	R = 175'	E = 0.02
Alleys	R = 175'	Inverted 6" Crown

Minimum length of superelevation runout = 100'

d. Minimum curb radii at intersections:

	Intersecting Res. Local and Res. Collector	Street Non-Res. Local and Collector
Secondary Arterial	30'	50'
Collector		
Residential	15'	20'
Collector		
Non-residential	20'	30'
Local		
Residential	15'	20'
Non-Residential	20'	30'

e. Minimum Safe Stopping Sight Distance

Secondary Arterial	325’
Collector	
Non-Residential	250’
Collector	
Residential	200’
Local	
Non-Residential	200’
Local	
Residential	150’

f. Minimum Safe Stopping Distance at Intersections

Secondary Arterial	500’
Collector	
Non-Residential	450’
Collector	
Residential	400’
Local	
Non-Residential	300’
Local	
Residential	250’

g. Intersections. All curb returns shall be designed with a wheel chair ramp meeting the requirements of Standard Drawing ST-13 included in these design standards. No drainage structures shall be allowed in the wheelchair path. Intersections shall be approached on all sides by leveling areas. Where the approach grade for either or both streets exceed 3 percent, the leveling area shall be a minimum length of 100 feet measured from the intersection of the edge of gutter flag or edge of road, within which no grade shall exceed a maximum of 3 percent with a maximum crossfall of 6” at the throat of the radius returns of the intersecting street. Right angle intersections shall be used whenever practicable. When local streets intersect collector or arterial streets, the angle of intersection of the street centerlines shall not be less than 75E. A diagonal sight distance easement must be provided (as shown on sheets ST-7 and ST-8) on the property lines substantially parallel to the chord of the curb radius.

Elevations at street intersections shall be computed by extending curb grades to the P.I. of the intersection of curbs. A minimum of 0.3 feet fall around a curb return is required. Elevations at every 10 feet around

the curb return and centerline stationing at all radius points shall be shown on the plan.

All pavement stationing shall be shown using face of curb data.

h. Plan. The following information shall be shown on the plan portion of each plan sheet:

(1) Width of right-of-way.

(2) Width of pavement (back-to-back of curbs).

(3) Curb and right of way radii with elevation and stationing.

(4) Location and size of existing utilities, meters, valves, poles, street markers, signs, traffic signals, trees, shrubs, drainage ditches, structures, storm sewers, easements, sanitary sewers and manholes. The proposed location of any of the above must also be shown. Central angle, centerline radius, arc length, and tangent distance of horizontal curves. Stationing of beginning and end of paving, PC and PT stationing of curves and ties to lot corners. All lot dimensions.

i. Profile. The following information shall be shown on the profile portion of each plan sheet:

(1) Existing ground lines at both right of way lines with elevations shown at 50’ intervals.

(2) Proposed top of curb grades for both curbs.

(3) Centerline elevation and stationing at areas where typical cross sections are not applicable.

(4) Top of curb elevations and stationing at beginning and end of paving, beginning, end, and P.I. of vertical curves, and mid-ordinate of vertical curves.

(5) Elevation and station of low point of sags.

(6) Top of curb shall be noted.

j. Typical Section. A typical section shall be shown on the first plan sheet indicating:

(1) Pavement type, width, and thickness

(2) Crown

(3) Curbs

(4) Parkway width

(5) Right of way width

(6) Sidewalks

k. Cul-de-sacs. Information needed on cul-de-sacs is shown on Standard Drawing ST-5, included in these design standards.

l. Expansion Joints. Expansion joints in concrete paving shall be placed as shown on standard drawings at intersections unless otherwise shown on plans and at all structures crossing the roadway such as bridges, box culverts, etc.

Expansion joints are required around junction boxes, inlets, etc.

m. Contraction Joints. Contraction joints in concrete paving shall be placed as shown on standard drawings at intervals of not more than 25 feet and not more than 25 feet from any expansion joint. Contraction joints shall be without dowels unless otherwise specified on plans.

n. Longitudinal Joints. Longitudinal joints shall be placed as shown on the Standard Drawings included in these design standards.

o. Manholes. Manhole designation and elevation of top of manhole must be given when located within right-of-way.

p. Storm Sewers. Flow line elevations must be given for storm sewers within right-of-way.

q. Approaches to existing streets. All approaches to existing curb and gutter streets shall be Portland Cement Concrete to the radius points.

STREET STANDARDS
CITY OF BATTLEFIELD

	COLLECTOR STREETS		LOCAL STREETS		
	Normal	Residential	Multi-Family	Residential	Alleys
Characteristics	—Major thoroughfare plan —Connects between arterial streets —Serves multiple land uses	—Connects Residential Local Streets to Arterial Streets	—Access to multi-family residential properties	—Access to single family and duplex residential properties	—Access to residential properties
Right-of-Way Width	80	60	60	50	24
Parking	None	None	One Side	One Side	One Side
Maximum Grade (%)	7%	7%	10%	10%	10%
Minimum Grade (%)	0.5%	0.5%	0.5%	0.5%	0.5%
Pavement Width (Back-to-Back)	44’	36’	36’	32’	20’

STREET RIGHT-OF-WAY AND CONSTRUCTION REQUIREMENTS

	Parkway	Primary Arterial	Secondary Arterial	Collector	Residential Collector	Non-Res. Local	Res. Local	Alleys
Right of way – Normal	120’	80’	80’	80’	50’	60’	50’	24'
Pavement Width –	68’	68’	68’	44’	36’	36’	32’	20’
Sidewalk Requirements	As Needed	Both Sides	Both Sides	Both Sides	Both Sides	One Side	One Side	One Side
Minimum Centerline Radius	To Be Designed	To Be Designed	400’	400’	300’	300’	175’	175’
Parking Prohibitions	Both Sides	Both Sides	Both Sides	Both Sides	Both Sides	Both Sides	As Needed	One Side

RIGHT-OF-WAY TRIANGLE REQUIREMENTS

Intersection of / With	Parkway	Primary Arterial	Secondary Arterial	Non-Res. Collector	Residential Collector	Non-Residential Local	Residential Local	Alley
Parkway	A	A	A	B	B	B	B	B
Primary Arterial	A	A	A	B	B	B	C	C
Secondary Arterial	A	A	B	B	C	C	D	D
Collector	B	B	B	C	C	C	D	D
Residential Collector	B	B	C	C	C	C	D	E
Non-Res. Local	B	B	C	C	C	C	D	E
Residential	B	C	D	D	D	D	E	E
Alley	B	C	D	D	E	E	E	E

KEY: A – 100’ X 100’ ROW triangle w/separate right turn lanes
B – 30’ X 30’ ROW triangle w/50’ corner radii
C – 10’ X 10’ ROW triangle w/30’ corner radii (or 15’ ROW radius)
D – 10’ X 10’ ROW triangle w/20’ corner radii (or 15’ ROW radius)
E – No ROW triangle w/15’ corner radii

B. SIDEWALKS

1. General. Sidewalks are required in subdivisions on at least one side of residential streets and on both sides of collector and arterial streets. All new constructed walks shall meet the requirements of the 1990 Americans with Disabilities Act as published in the Federal Register Vol. 156, No. 144/Friday, July 26, 1992, pages 35459 through 35511.

2. Design. Sidewalks are constructed from Class "A" Portland cement concrete, 6 inches thick, 8-inch reinforced thickness is required in commercial driveways and 18 inches on either side of said area. The sidewalk shall be constructed such that panels are formed using control joints that shall extend to ¼ the depth of the sidewalk. If a grooving tool is used to form the control joint, the groove shall not be wider than ¼" and edged with a 1/8" radius. If the control joints are sawed, the groove shall not be less than 1/8" wide. Whichever method of grooving is used the control joints are to be cut such that the resulting panel lengths are not less than 4 feet nor greater than 6 feet. Edges of the slab shall be edged with an edging tool that has a ¼" radius.

   A sidewalk plan must be prepared to show the sidewalk in plan, profile, and typical cross section. This plan may be included as part of the street plan. For sidewalks to be constructed on unimproved streets, it is necessary to obtain sufficient field data to determine the probable future grade of the street curb and design the sidewalk accordingly. Additional right-of-way may have to be provided.

3. Location. The outside edge of the sidewalk shall be placed 1 foot inside the street right-of-way line.

4. Width. Residential sidewalks shall be a minimum width of 4 feet.

5. Expansion Joints. Bituminous preformed expansion joints, ½" thick and precut to the width of the sidewalk, shall be indicated on the plans 18" on each side of driveways, intersecting walks, curbs, and other locations as required.

   Expansion joints shall be placed at the locations specified on the plans or standard drawings. Expansion joints shall be placed between the sidewalk and all structures, such as light standards, traffic light standards, traffic poles, and columns, etc., which extend through the sidewalk.

6. Ramps.

General. All ramps shall be constructed to the least possible slope with a maximum allowable slope of 1:12 (8.33%). The maximum rise for any run shall be 30 inches. A level landing area of ¼"/ft. (2%) cross slope or less shall be constructed at the top and bottom of each ramp or ramp run. The minimum length of landing areas are to be 60". The minimum width of a ramp shall be 48 inches, exclusive of flared sides.

If a ramp is located where pedestrians must walk across the ramp, or where it is not protected by handrails or guardrails, it shall have flared sides with a maximum slope of 1:12 (8.33%). Curb ramps with returned curbs may be used where pedestrians would not normally walk across the ramp.

No ramp shall be permitted to project beyond the curb into vehicular traffic. Curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

All ramped surfaces shall be constructed using colored concrete to provide a visually contrasting surface as per paragraph 4.29.2 of the Americans with Disabilities Act of 1990. This color shall be either Solomon Grind-Chem Service Color #417 – Red, (or equivalent red coloration), with 4½# of pigment per 94 lb. of Portland cement for truck or plant mixed full depth colored concrete, or (1) 60# bag of dry shake per 100 S.F. with a minimum thickness of ¼" for surface treated areas. Base concrete is to be mag floated and be free of surface water before application.

All ramps shall have a detectable warning comprised of tooled groves spaced 6" apart, constructed perpendicular to direction of travel. Grooves are to be constructed to same specifications as tooled control joints.

Curb ramps shall be provided at all street intersections, at any marked midblock crossing, and any curbed transitions. Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes (1/4" or greater change in elevation).

Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides. If diagonal (or corner type) curb ramps have returned curbs or other well-defined edges, such edges shall be parallel to the direction of pedestrian flow. The bottom diagonal curb ramps shall have 48 inches minimum clear space.

If diagonal curb ramps are provided at marked crossings, the 48 inches clear space shall be within the markings. If diagonal curb ramps have flared sides, they shall also have at least a 24-inch long segment of straight curb located on

each side of the curb ramp and within the marked crossing.

Any raised islands in crossings shall be cut through level with the street or have curb ramps at both sides and a level area at least 48 inches long between the curb ramps in the part of the island intersected by the crossings.

C. CURB AND GUTTER

1. General. Curb and gutter are required on all public improvement street projects.

2. Design. Curb and gutter are to be constructed from Class "A" Portland cement concrete. The width of the curb and gutter is to be 2 feet 6 inches. The curb height is to be 6 inches, and the gutter cross slope is to be 2 inches in 2 feet. The thickness of the gutter shall be 6 inches for residential streets and 8 inches for collector streets. The street plan shall show the top of curb elevation in the profile. At driveway locations shown on the plans, the gutter is to be carried across the drive while the curb is depressed to match the driveway slope. If driveway locations are now shown on the plans, curbs cannot be depressed.

3. Expansion Joints. Bituminous preformed expansion joints, ¾ inch thick and precut to the exact cross section of the curb and gutter shall be placed at all driveway and intersection radii and at intervals of not more than 200 feet.

D. DRIVEWAYS

1. General. Driveway approaches are located to serve the operation of automobiles and other vehicles from the street pavement to a garage, parking area, building entrance, structure, or other approved use located on the property.

2. Design. Residential driveway approaches shall be constructed using 6" thick Class "A" concrete. All driveway pavement shall be poured over 4" thick compacted Type I aggregate base. When a driveway approach intersects an existing sidewalk, the area of the sidewalk within the driveway area including both sides of the sidewalk transition sections to meet the drive elevation or 18 inches, whichever is greater, shall be removed and reconstructed with 6-inch thick concrete. The cross slope of the sidewalk area is not to exceed ¼"/ft. or 1:50 (2%). The grade of the driveway approach from the gutter line shall rise on a constant grade to the front edge (street side) of the sidewalk area. The slope of the driveway approach shall be at least 1:48 (1/4"/ft.) and not to exceed 1:8 (1½"/ft.).

Commercial/non-residential driveway approaches shall be constructed using 8" thick reinforced Class A Portland Cement Concrete. All driveway pavement shall be poured over 4" thick compacted Type I aggregate base. Reinforced concrete shall be either fibermesh or #4 rebar 18" O.C. When a driveway approach intersects an existing sidewalk, the area of the sidewalk within the driveway area, including both sides of the sidewalk transition sections to meet the drive elevation or 18 inches, whichever is greater, shall be removed and reconstructed with 8-inch reinforced thick concrete. The cross slope of the sidewalk area is not to exceed ¼"/ft. or 1:50 (2%). The grade of the driveway approach from the gutter line shall rise on a constant grade to the front edge (street side) of the sidewalk area. The slope of the driveway approach shall be at least 1:48 (¼"/ft.) and not to exceed grade dimension shown on ST-14.

No driveway approach shall be permitted which will interfere with any existing parking meters, signs, traffic control devices, plantings, cables, poles, guys, water mains, gas mains, or other public utilities. No part of any driveway approach may be located within 4 feet of a drop inlet or other drainage structure nor a pedestrian ramp.

No part of any driveway approach shall be located within 40 feet of a point on the right-of-way opposite the end of a raised median.

Joint driveway approaches shall be permitted only if there is a perpetual mutual access agreement approved by the City of Battlefield and filed of record in the Greene County Recorder's Office.

The width of residential driveway approaches shall not exceed 22 feet without permission from City of Battlefield and shall not be less than 12 feet for new construction, and not less than the existing approach for reconstruction.

All driveway approaches shall be located to provide the following minimum clearances: Nearest edge of the driveway to nearest right-of-way line of alleys, 10 feet; nearest edge of the driveway to property line, 5 feet; on corner lots, nearest edge of the driveway to nearest right-of-way line of an intersecting street, 20 feet, but in no case shall the driveway return extend closer than 15 feet to the intersection right-of-way line extended. Where sight distance triangles exist, the nearest edge of the driveway to nearest corner of triangle shall be at least 20 feet.

The edges of driveway approaches may be skewed so that the angle between the street right-of-way line and the edge of the driveway approach is not less than 60 degrees.

The radius of the driveway approach shall not, in any case, extend beyond the projection of the adjacent property line, extended perpendicularly to the right-of-way line.

The maximum radius of a driveway return shall not exceed the distance between the edge of the roadway and the right-of-way line, or 15 feet, whichever is smaller.

3. Expansion Joints ½”

4. Sawcutting and Gutter

The curb and gutter section in front of a driveway (radius point to radius point) shall be sawcut full depth and removed before the driveway is poured. The entire curb and gutter section would then be replaced with Class A concrete with the depth equal to that of the adjacent approach. Any curb and gutter broken or cracked outside the radius points during this removal shall also be removed and replaced accordingly.

Any damage to the existing street shall be the responsibility of the contractor or replace as per the Technical Specifications for Public Improvements.

E. EARTHWORK

1. Embankment Construction

All embankments required for construction of public streets and alleys must be compacted. The method of compaction and densities are as required in the latest revision of the City of Battlefield Technical Specifications for Public Works Construction. All trees, shrubs, and plants designated to remain within the public right-of-way shall be shown and clearly noted on the plans. All other plantings shall be removed from the right-of-way. The plans shall require that the public right-of-way be left in a finished and neat appearing condition.

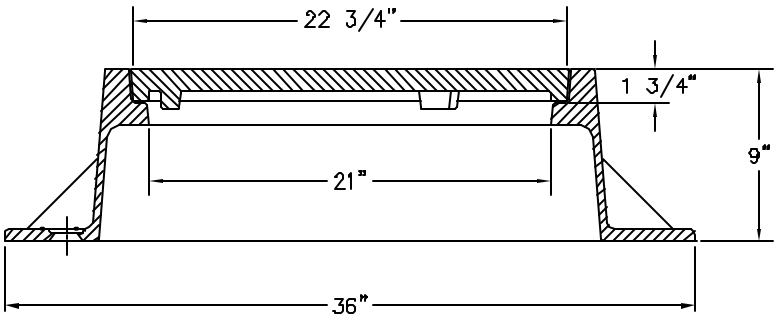
2. Subgrade Compaction

The plans shall require that the street subgrade for both public and private improvements be compacted as required in the latest revision of the City of Battlefield Technical Specifications for Public Works Construction. All street sub-grades shall have at least 4” of compacted aggregate (meeting Type I Aggregate Base requirements) base. Aggregate should extend 1’ – 0” outside the limits of the street.

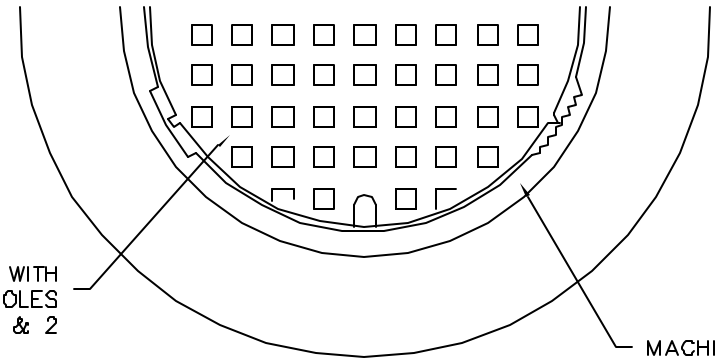
CITY OF BATTLEFIELD
STANDARD DRAWINGS
AND FIGURES

ADOPTED OCTOBER 15, 2002

MANHOLE RING & COVER
TYPE "A"



TYPE "A" SECTION VIEW



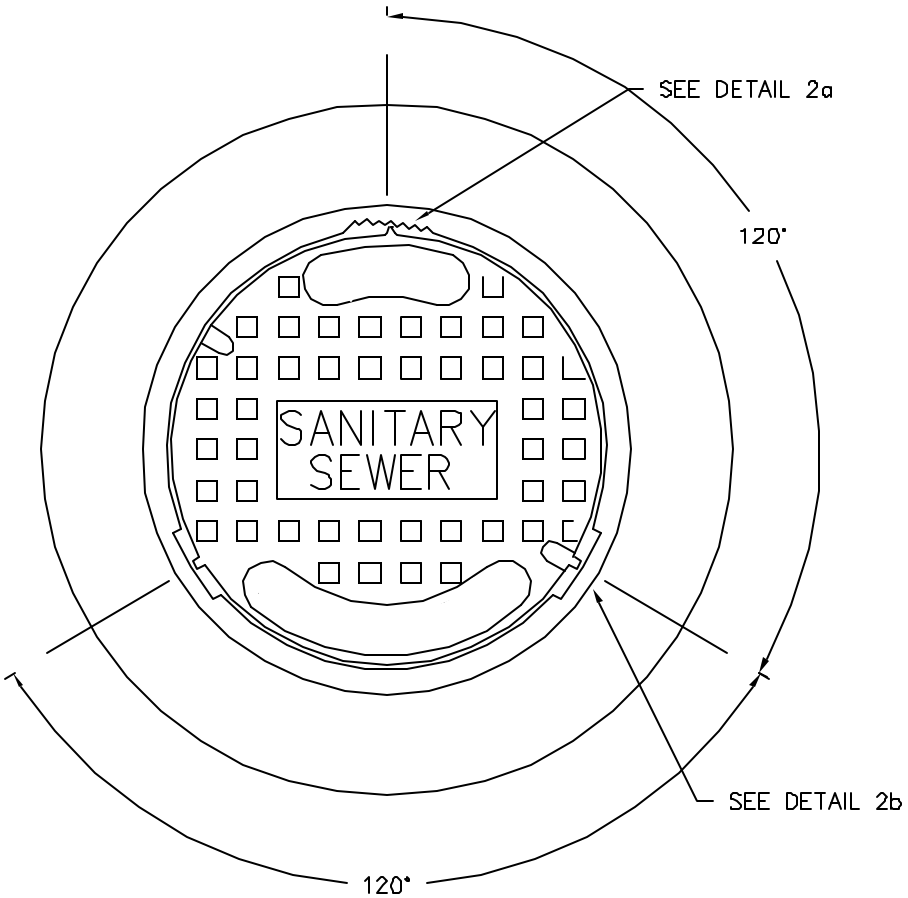
TOTAL WEIGHT
RING AND COVER
TYPE "A" = 540 lbs.

DETAIL "1" CONCEALED PICKHOLES

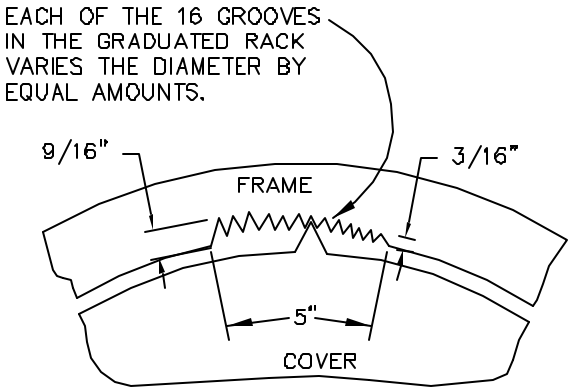
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MANHOLE RING AND COVER (TYPE "A")	ADOPTED: 10/15/02 SAN–1

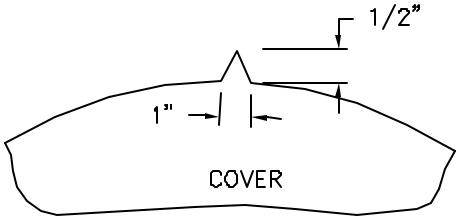
DETAIL "2" NON ROCKING COVER

SEE SAN-1 FOR TYPE "A" SECTION VIEW

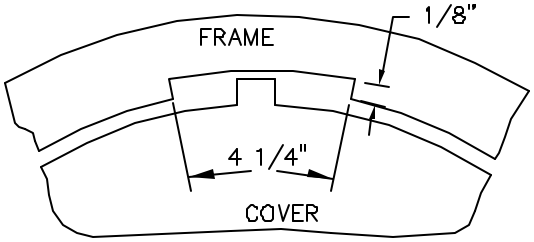


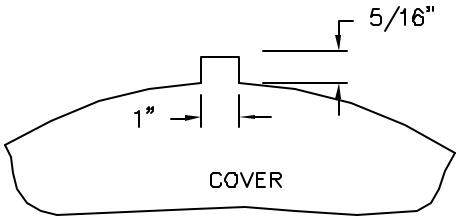
LOADS HS20
COMPONENT NOS.: FRAME NEENAH 1715-2001, LID 1715-XXXX
MATERIAL: CAST GRAY IRON ASTM A-48, CLASS 35B
FINISH: NO PAINT
WEIGHT: FRAME APPROX. 234#, LID APPROX. 127#





DETAIL 2a

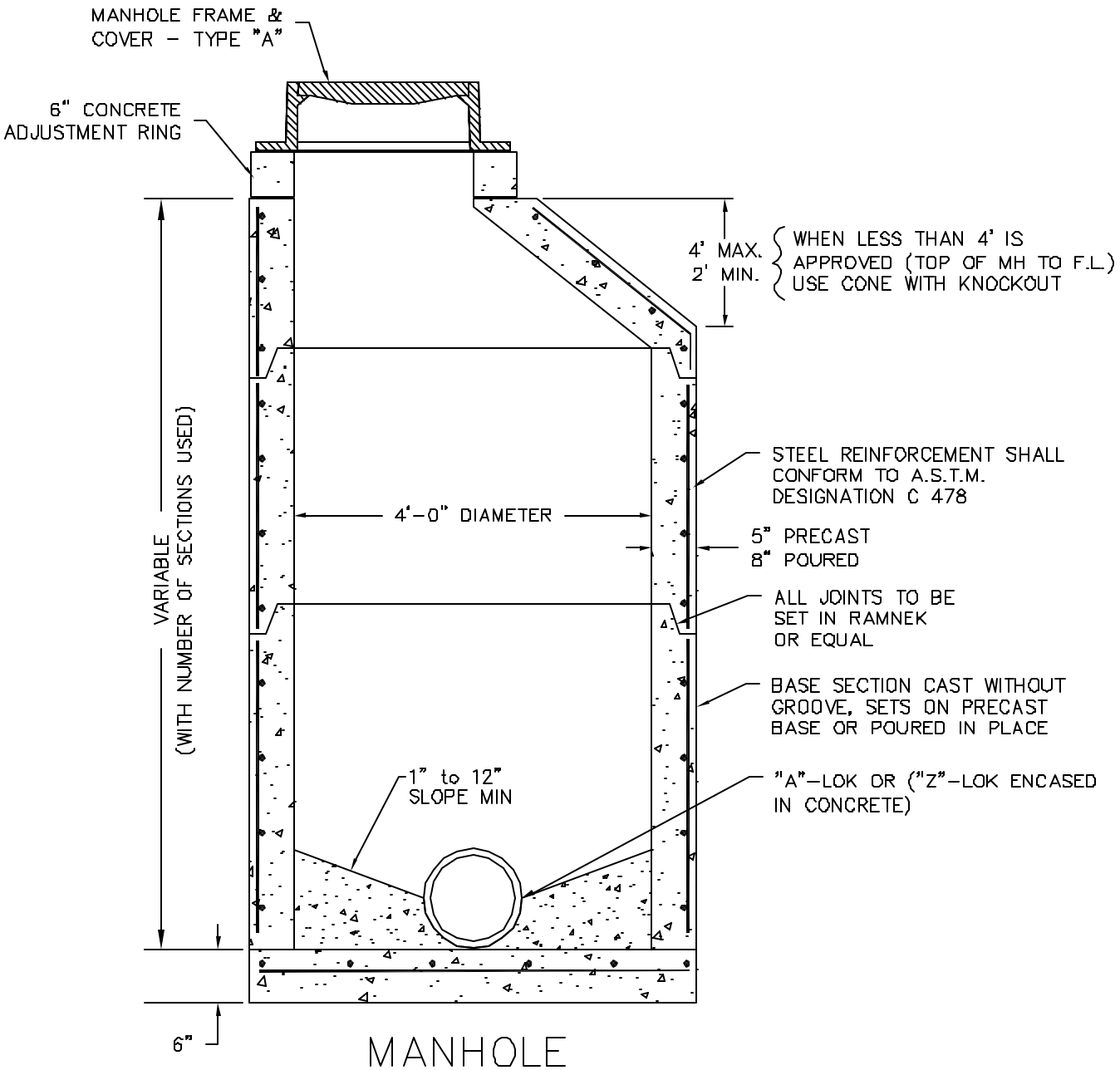




DETAIL 2b

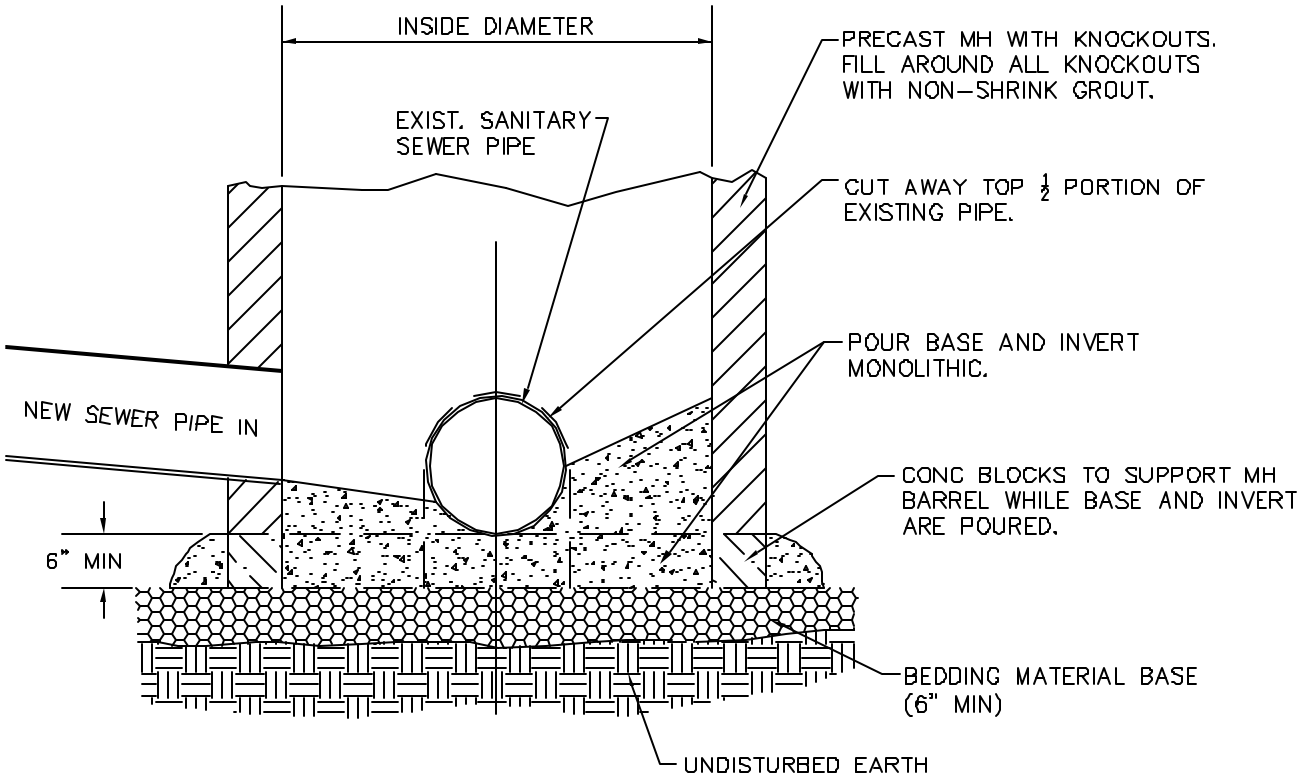
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MANHOLE RING AND COVER (NON-ROCKING)	ADOPTED: 10/15/02 SAN-2

NOTE:
NO MORE THAN 2 ADJUSTMENT RINGS,
NOT TO EXCEED 18-INCHES

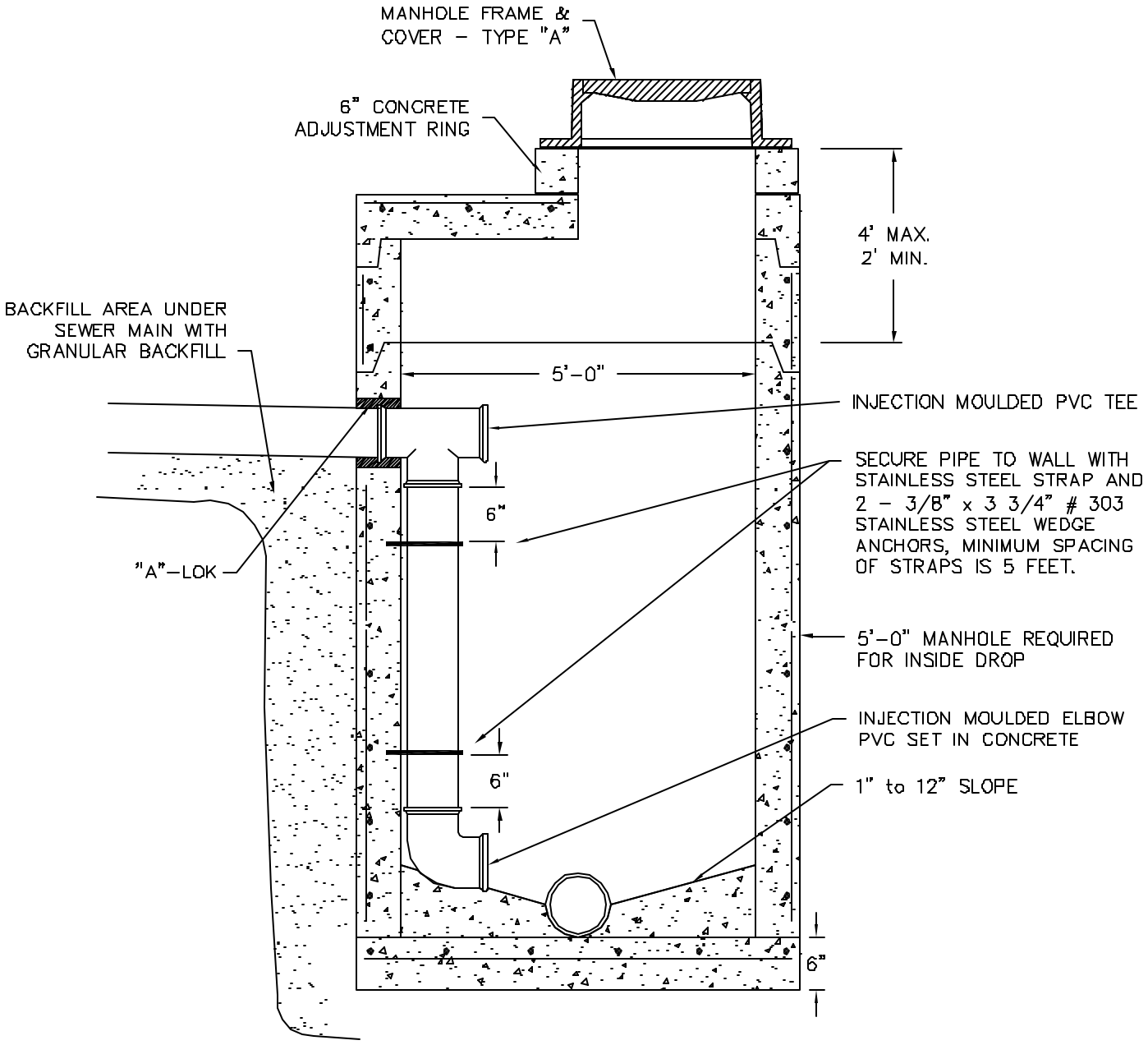


MANHOLE
8" TO 24" PIPE

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD FOUR-FOOT DIAMETER MANHOLE	ADOPTED: 10/15/02 SAN-3



CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	NEW MANHOLE ON EXISTING LINE	ADOPTED: 10/15/02 SAN-4

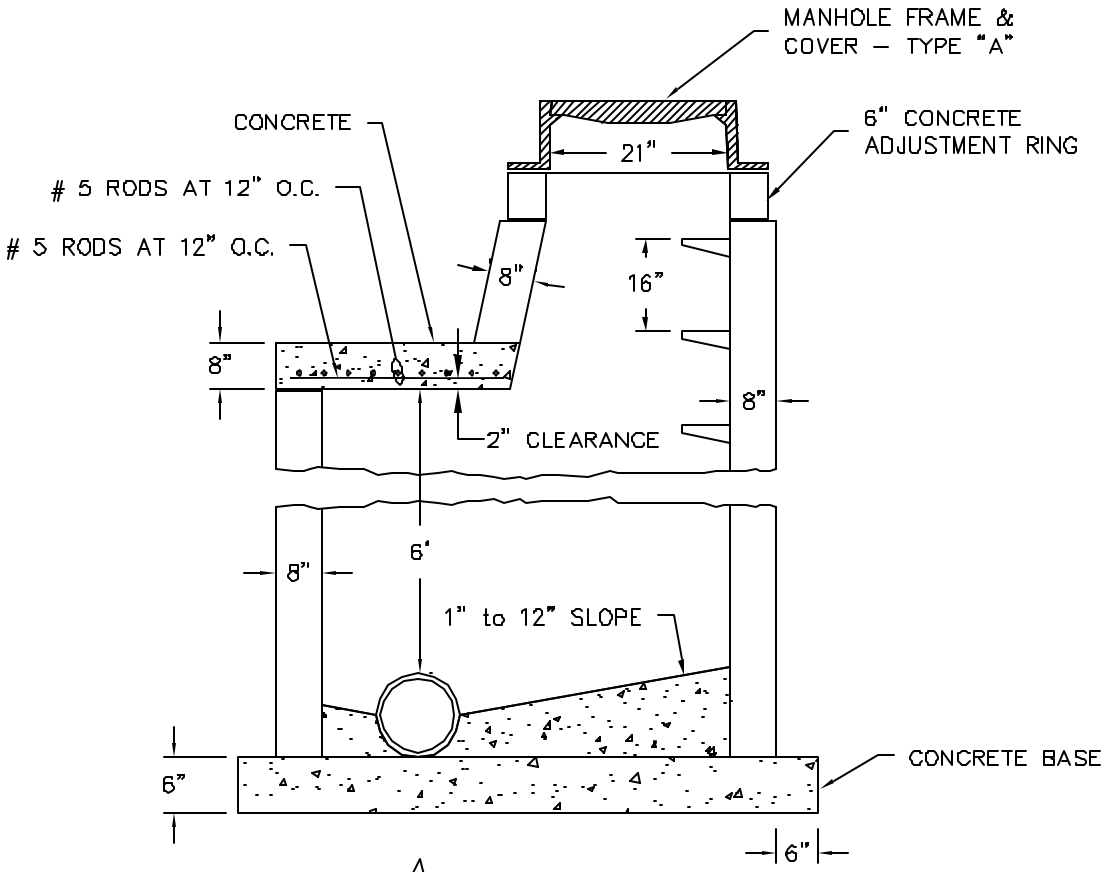


DISTANCE FROM PIPE INLET TO MANHOLE FLOWLINE FOR 8" PIPE.
0'–2' BUILD INSIDE FLUME
2'–3' SPECIAL DESIGN REQUIRED
3'– BUILD DROP MANHOLE

CONSTRUCTION METHODS FOR DROP MANHOLE TO BE SAME AS MANHOLE SAN–3

DROP MANHOLE
8" TO 24" PIPE

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	**DROP MANHOLE**	ADOPTED: 10/15/02 SAN–6

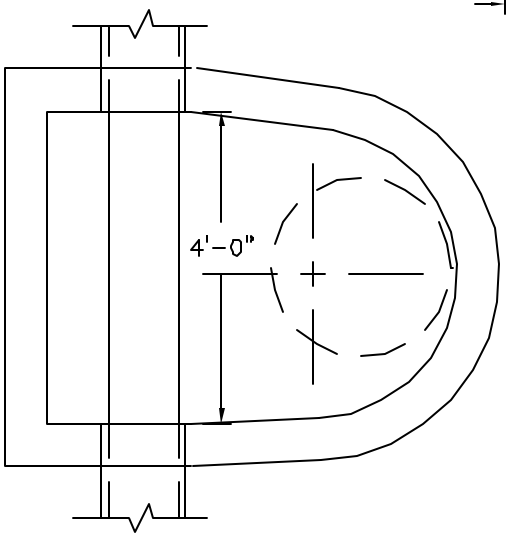


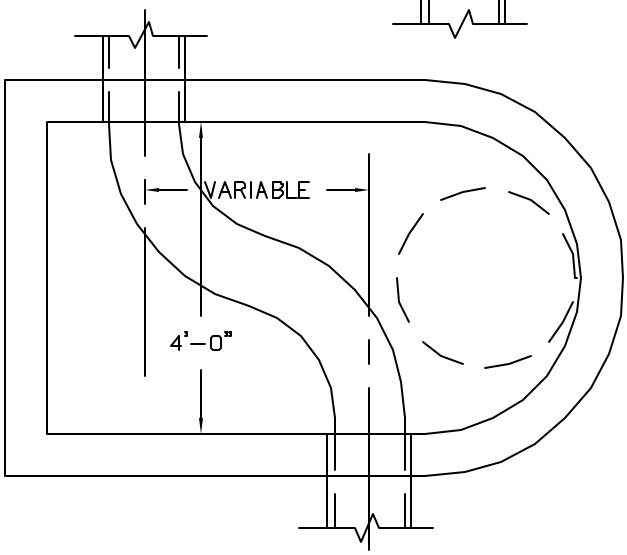
NOTES:

1. WALLS SHALL BE POURED CONCRETE OR PRECAST.

2. THICKNESS OF WALLS TO BE INCREASED TO 12" AT 12' BELOW UNDERSIDE OF FRAME.

3. CONSTRUCTION METHODS TO BE SAME AS STANDARD MANHOLES.





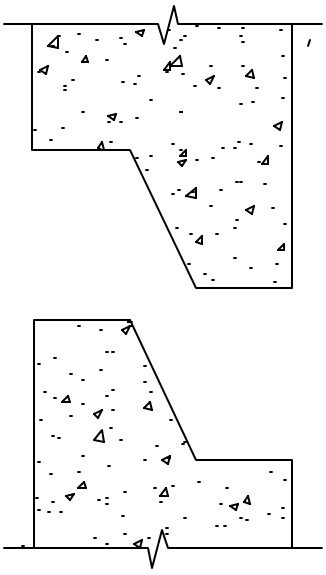
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	OFFSET MANHOLE	ADOPTED: 10/15/02 SAN–7

BITUMASTIC INSTALLATION (OR EQUAL)

SEALING OF TONGUE & GROOVE PRECAST MANHOLES

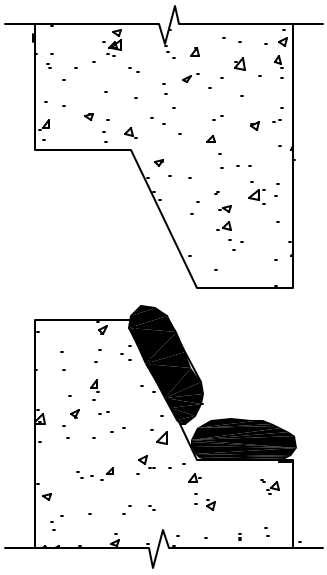
1. SURFACE PREPARATION (CLEANING)

REMOVE ALL LOOSE PARTICLES, DUST, DIRT, ETC.



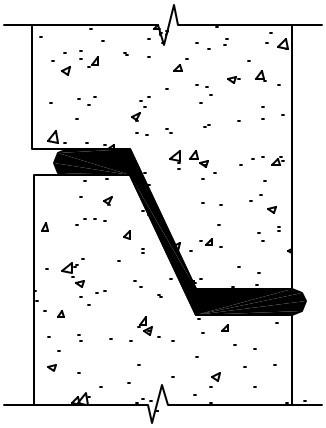
2. APPLYING BITUMASTIC SEAL

PLACE BITUMASTIC ROPE OR EQUAL IN GROOVE.

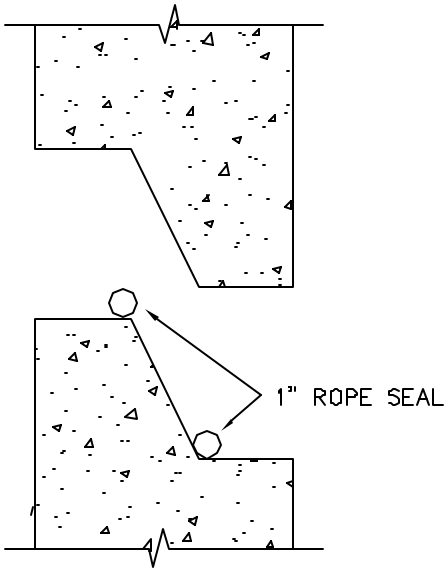


3. COMPLETION OF BITUMASTIC SEAL

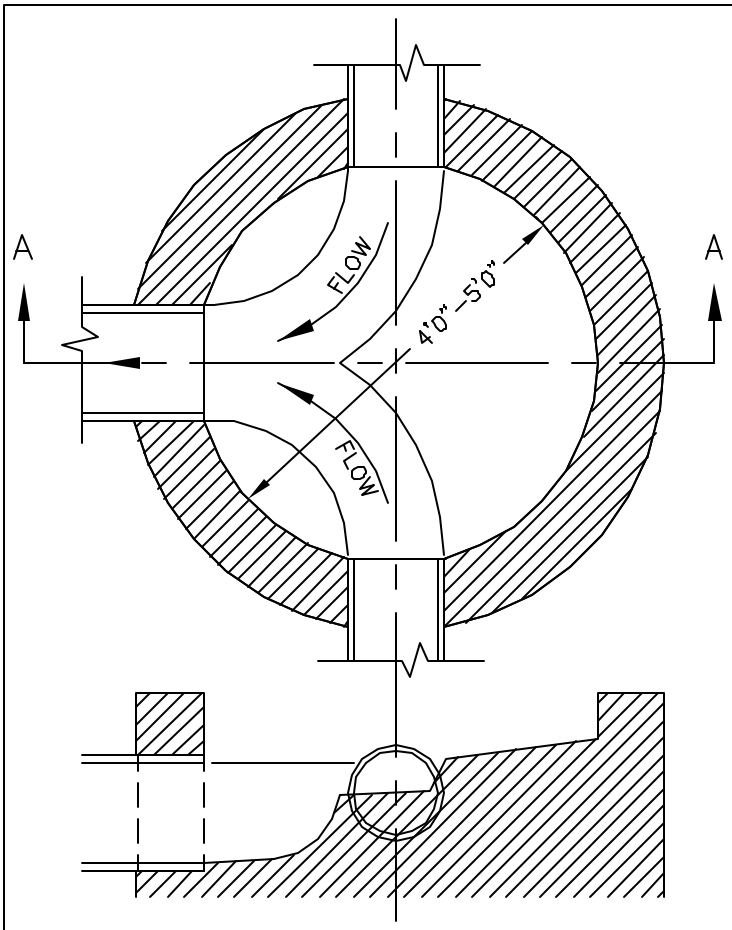
LOWER THE NEXT LENGTH OF PIPE (TONGUE INTO GROOVE) AND SEAL WILL BE ACCOMPLISHED BY WEIGHT OF PIPE.



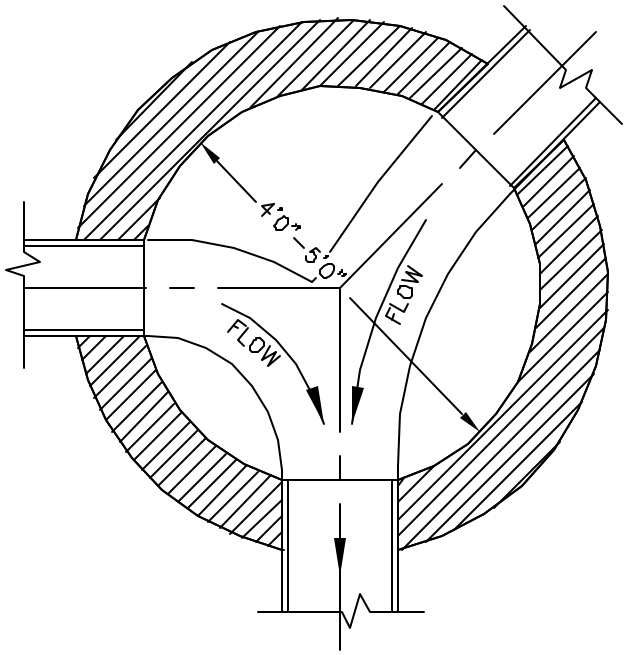
APPLYING ROPE SEAL

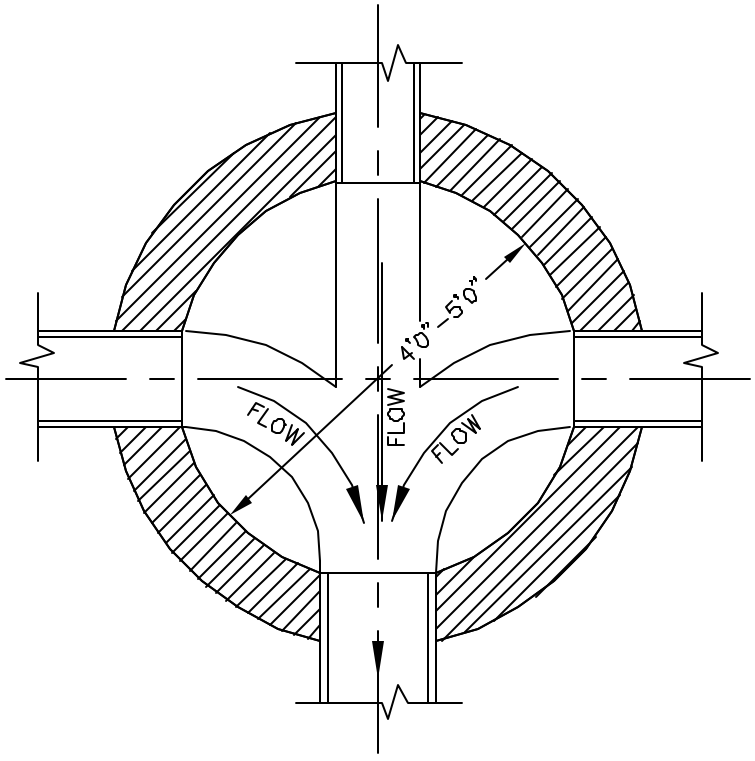


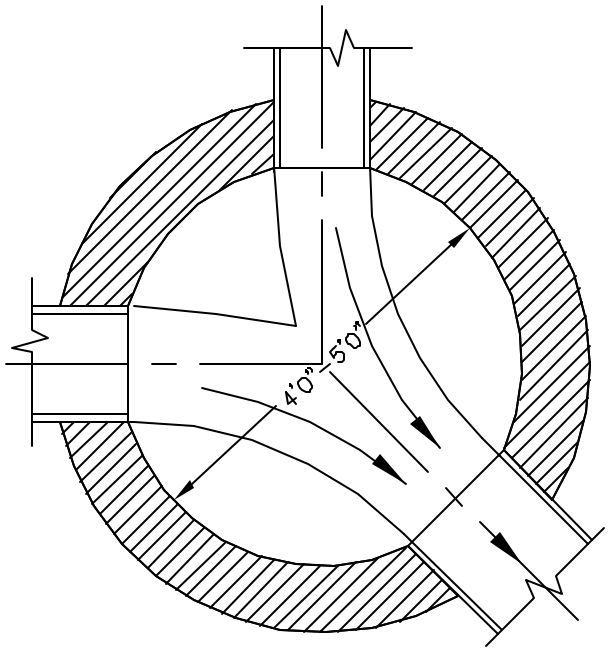
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	GASKET SEALING DETAILS FOR PRECAST MANHOLES	ADOPTED: 10/15/02 SAN–8



SECTION A-A





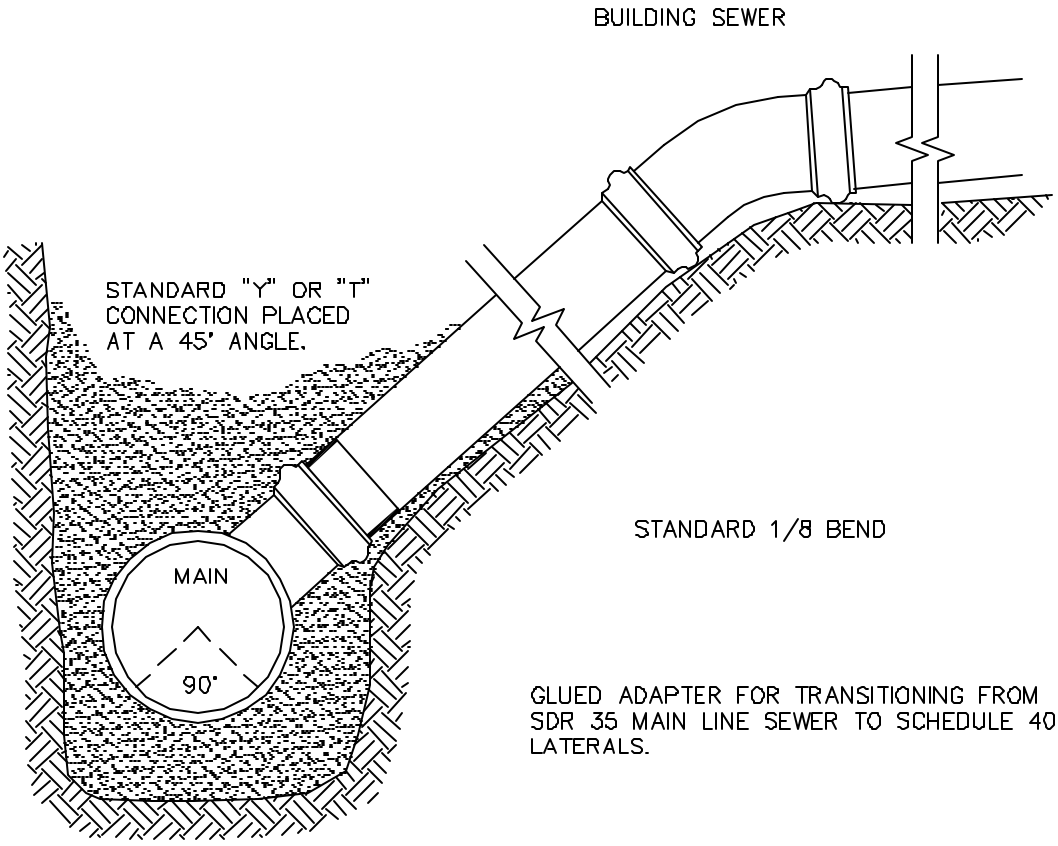


PIPES CANNOT ENTER MANHOLES AT ANGLES LESS THAN 90° TO EACH OTHER.

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	FLOWLINES FOR MANHOLE BASES	ADOPTED: 10/15/02 SAN-9

NOTE:

MOULDED TEES ARE REQUIRED FOR ALL LATERALS ON NEW SEWER LINES. ALL LATERALS SHALL BE SCHEDULE 40 PIPE AND JOINTS SHALL BE GLUED WITH AN APPROVED ADHESIVE.

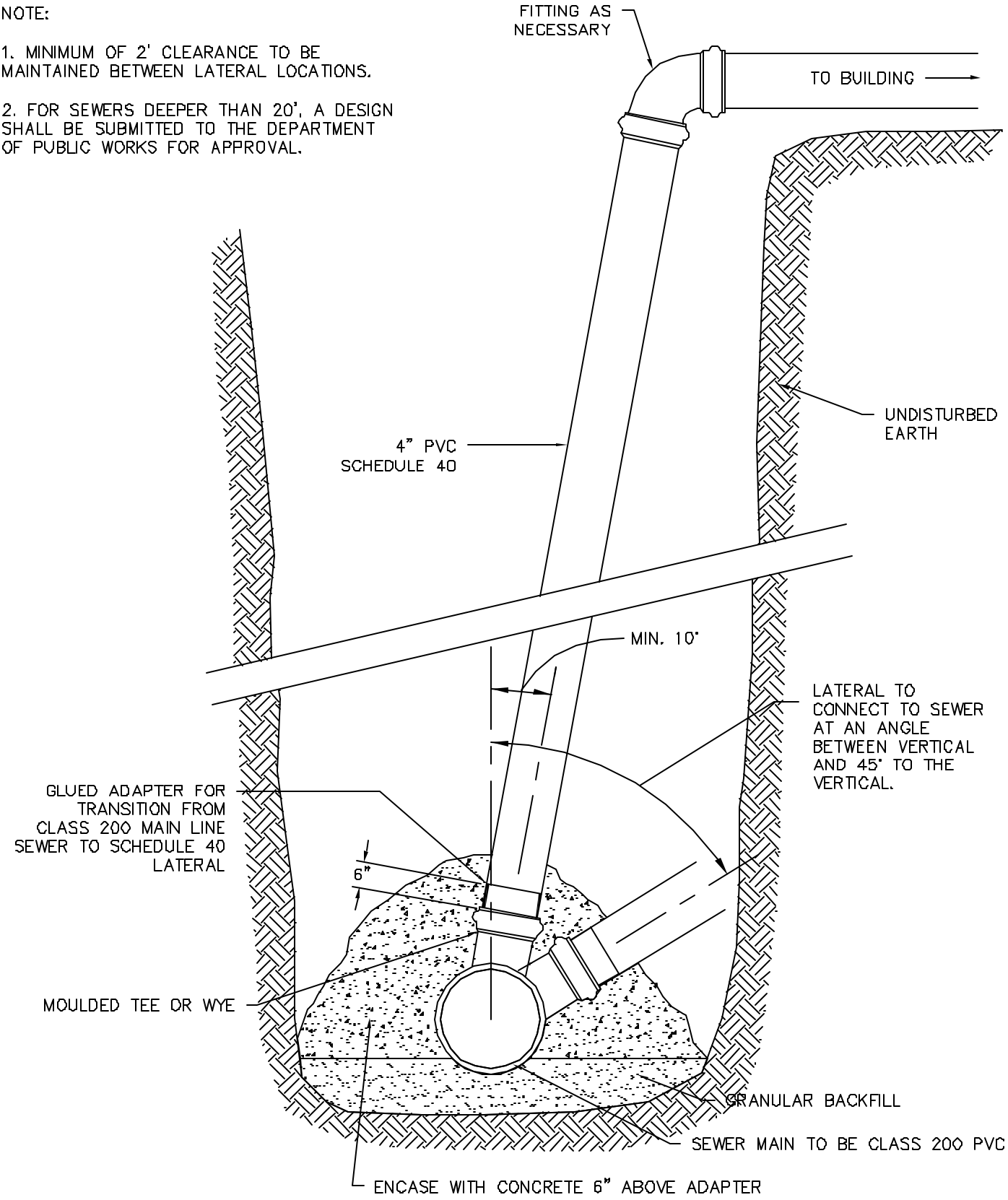


CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	HOUSE CONNECTIONS – LESS THAN 12'	ADOPTED: 10/15/02 SAN–10

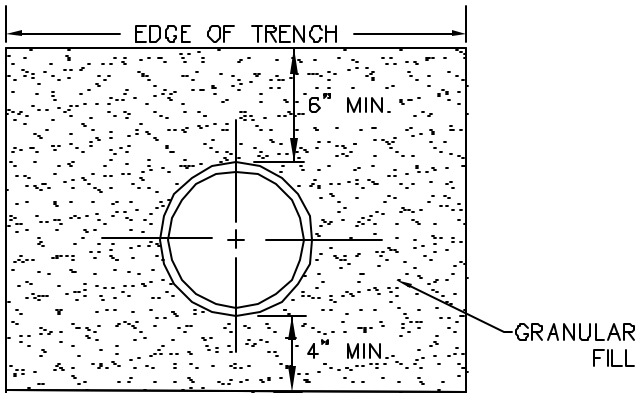
NOTE:

1. MINIMUM OF 2' CLEARANCE TO BE MAINTAINED BETWEEN LATERAL LOCATIONS.

2. FOR SEWERS DEEPER THAN 20', A DESIGN SHALL BE SUBMITTED TO THE DEPARTMENT OF PUBLIC WORKS FOR APPROVAL.



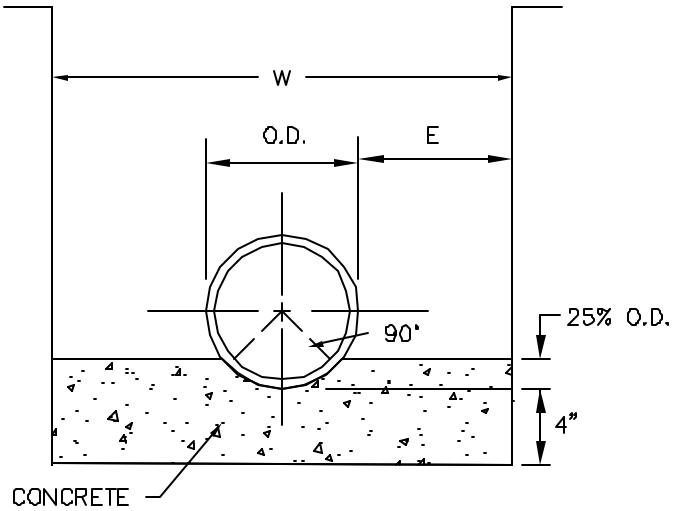
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	HOUSE CONNECTIONS – 12 FEET TO 20 FEET	ADOPTED: 10/15/02 SAN–11



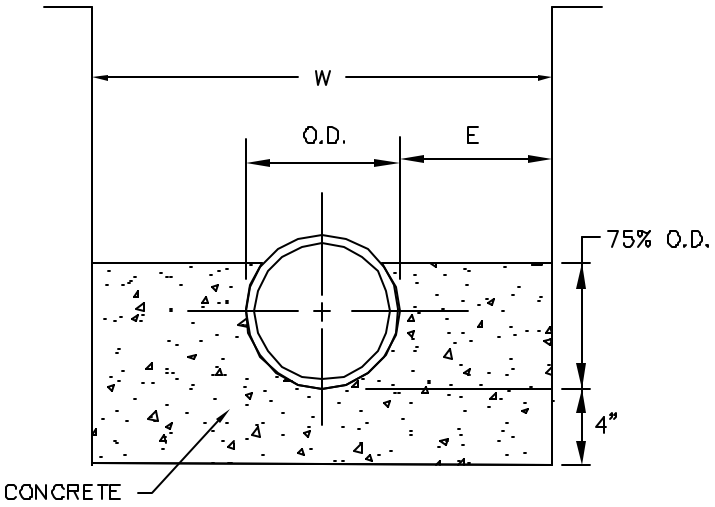
MINIMUM DEPTH OF GRANULAR BACKFILL -- 1/4 PIPE DIAMETER BUT NEVER LESS THAN 4" BELOW THE PIPE AND A MINIMUM OF 6" ABOVE THE PIPE.

GRANULAR BACKFILL MUST CONFORM TO BEDDING MATERIAL. (IN CUTS GREATER THAN 12' MINIMUM AGGREGATE COVER IS 12")

IMPROVED BEDDING

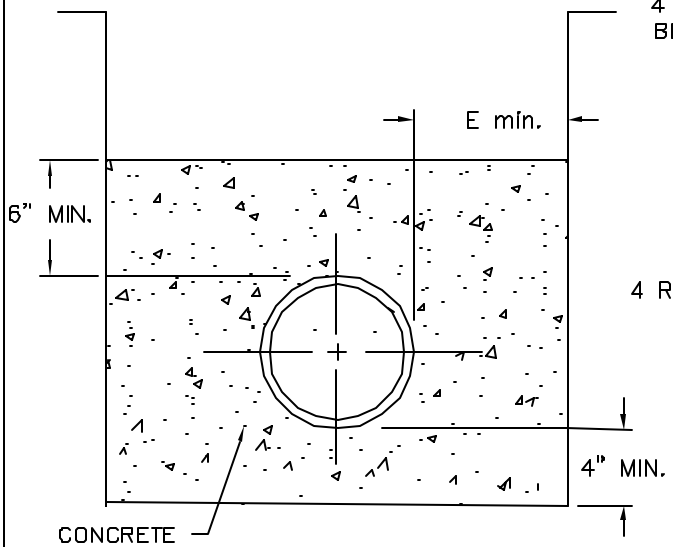


CONCRETE LOW CRADLE

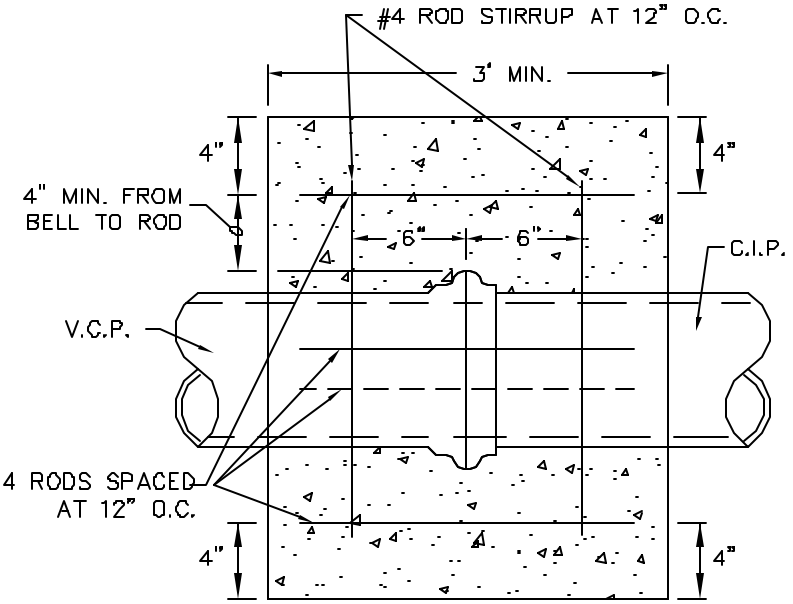


CONCRETE HIGH CRADLE

NOTE: W = TRENCH WIDTH
W = O.D. + 2E
E = 9" (6" to 24" PIPE)
E = 12" (27" to 36" PIPE)
E = 15" (42" to 72" PIPE)



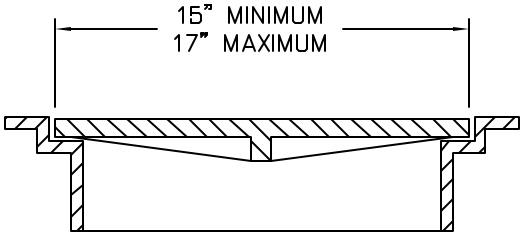
CONCRETE ENCASEMENT



FOR 8" PIPE A V.C.P.-C.I.P. "ADAPTER" FERNCO COUPLING OR EQUAL

V.C.P.-C.I.P. JUNCTION ENCASEMENT

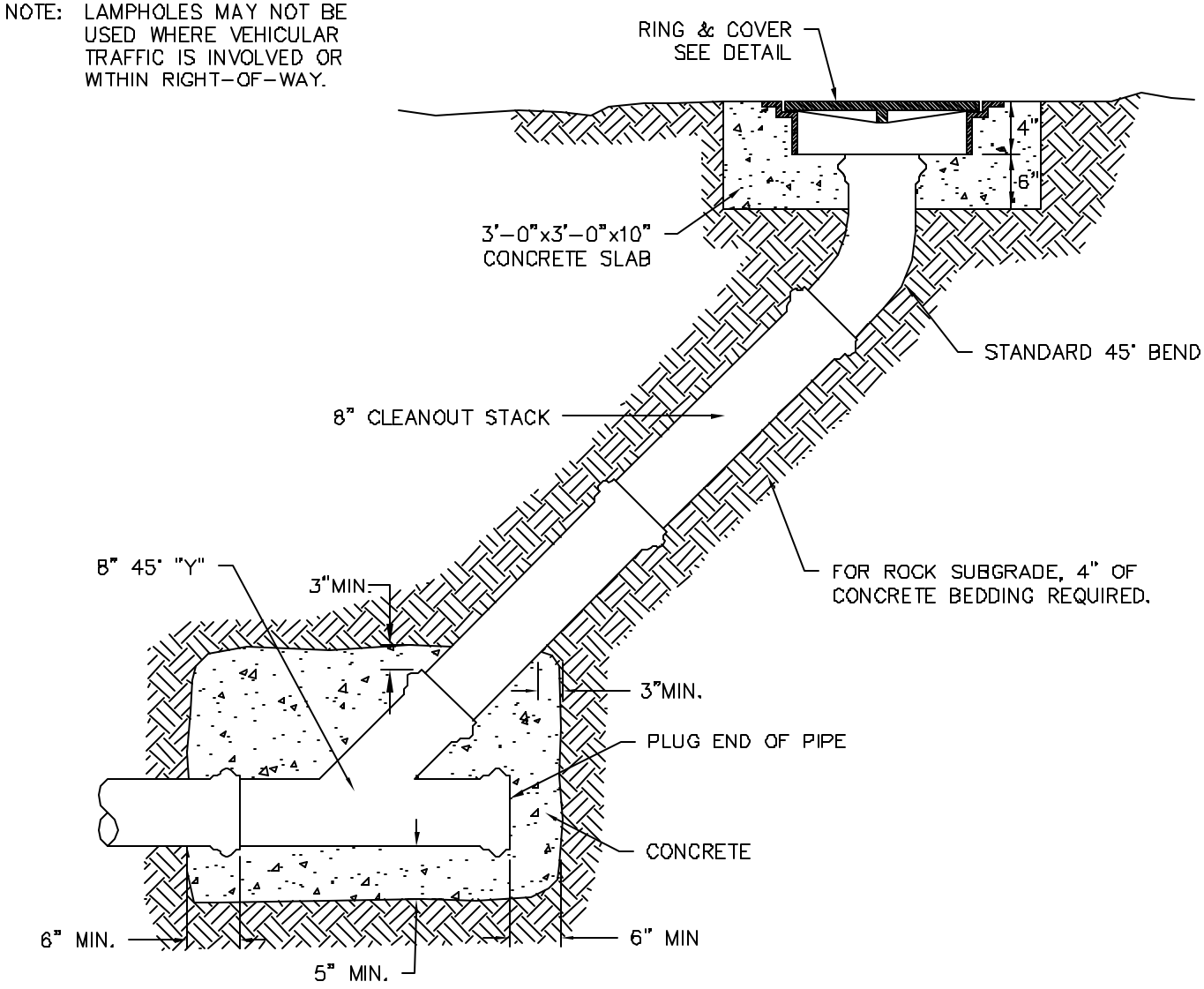
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**BEDDING STANDARDS**	ADOPTED: 10/15/02 SAN-12



MINIMUM WEIGHT 90 lbs.
NEENAH R-1976 OR EQUAL

RING & COVER DETAIL

NOTE: LAMPHOLES MAY NOT BE USED WHERE VEHICULAR TRAFFIC IS INVOLVED OR WITHIN RIGHT-OF-WAY.

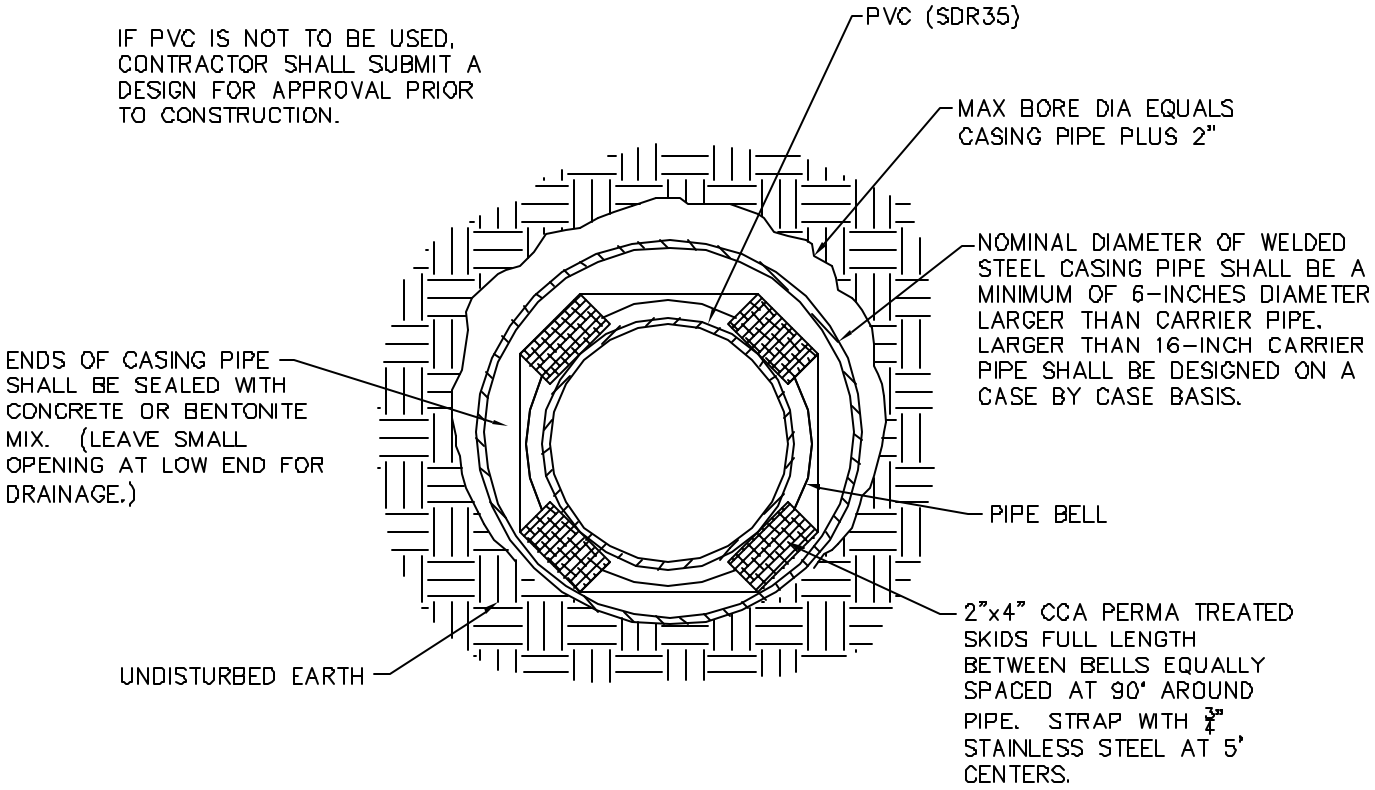


STANDARD CLEANOUT LAMPHOLE

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**LAMPHOLES**	ADOPTED: 10/15/02 SAN-13

NOTE:

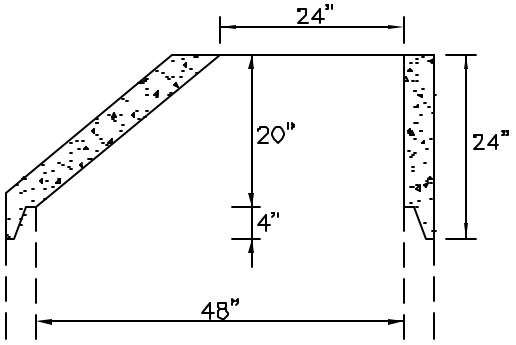
CONTRACTOR MAY USE RACI CASING SPACERS OR APPROVED EQUAL IN LIEU OF 2"x4" WOOD SKIDS.



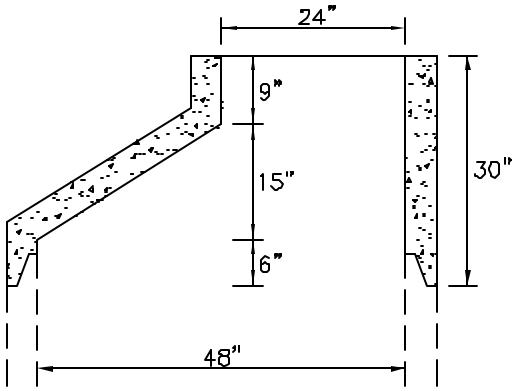
BORING CASING

TREATMENT FOR 8" SEWER, OTHER SIZES TO BE SIMILAR, APPROVAL WILL BE REQUIRED.

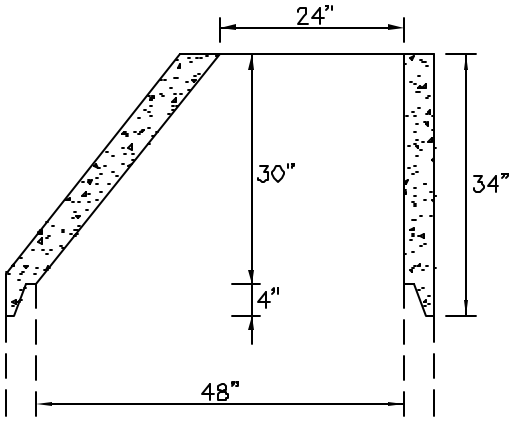
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**BORING DETAILS**	ADOPTED: 10/15/02 SAN-15



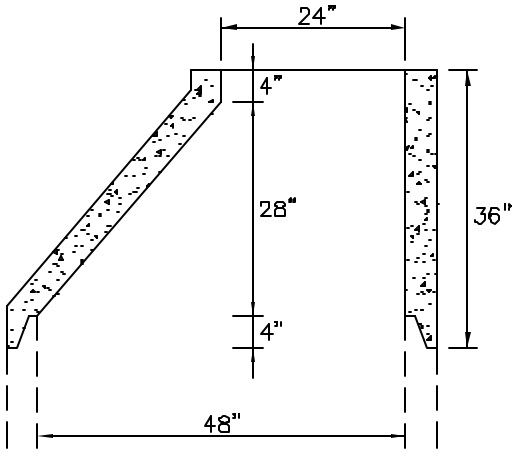
24" CONE



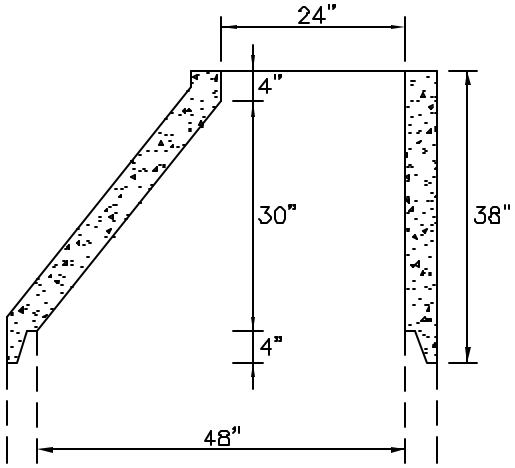
30" CONE



34" CONE



36" CONE



38" CONE

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**STANDARD CONE CONFIGURATION FOR MANHOLES**	ADOPTED: 10/15/02 SAN–16

MANHOLE TESTING TABLES
ALLOWABLE WATER LOSS PER 24 HOURS
4'–0" DIAMETER

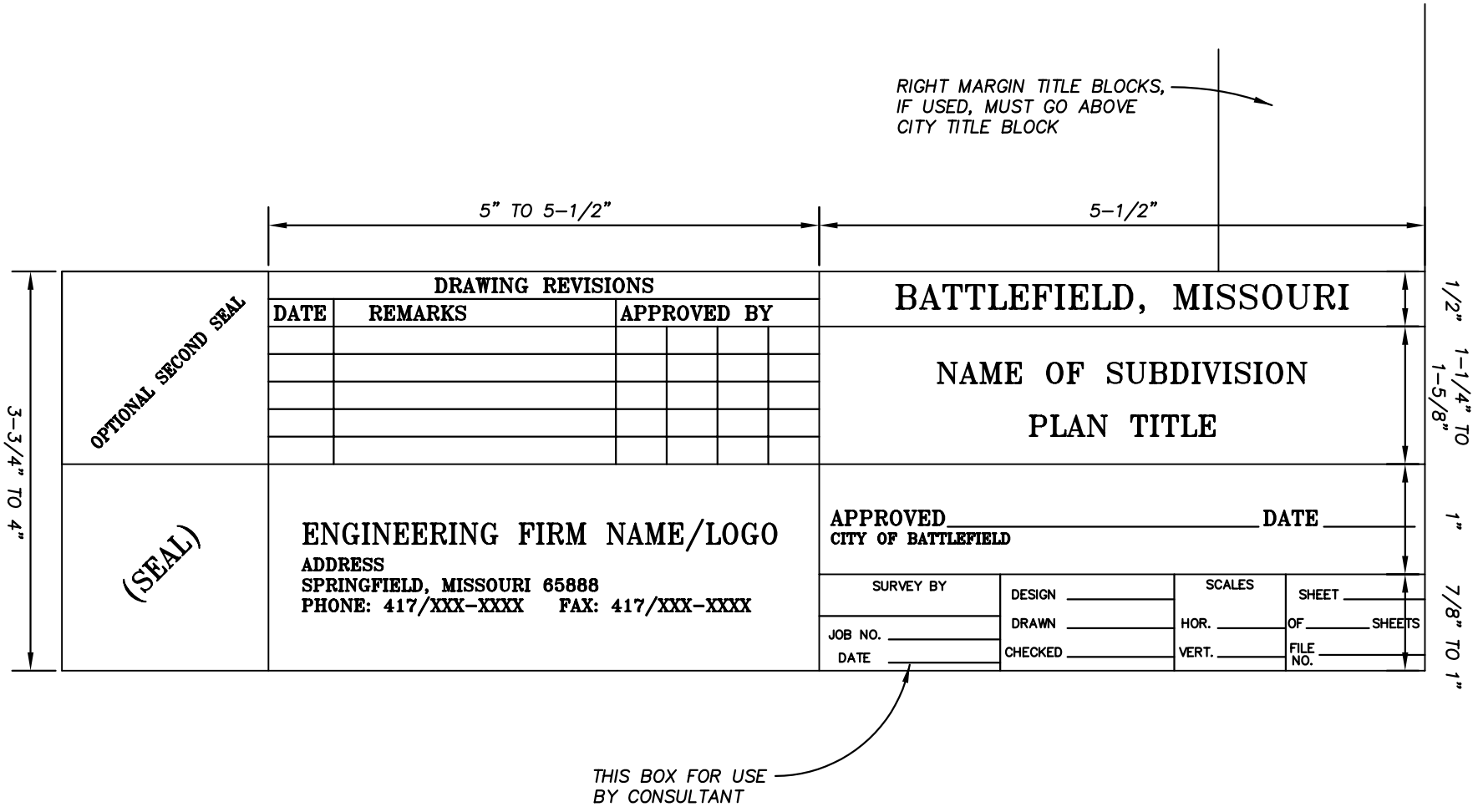
Manhole Depth (In feet)		Allowable Water Loss/24 Hrs (In gal.)	24" Cone Allowable Water Loss /24 Hrs (In inches)	30" Cone Allowable Water Loss /24 Hrs (In inches)	34" Cone Allowable Water Loss /24 Hrs (In inches)	36" Cone Allowable Water Loss /24 Hrs (In inches)	38" Cone Allowable Water Loss /24 Hrs (In inches)
Greater Than	Less than or equal to						
0	4.0	7.3	3.0	3.5	3.0	3.5	3.5
4.0	4.5	8.2	3.5	4.0	3.5	4.0	4.0
4.5	5.0	9.1	3.5	4.5	4.0	4.5	4.5
5.0	5.5	10.0	4.0	5.0	4.5	5.0	5.0
5.5	6.0	10.9	4.5	5.5	4.5	5.5	5.5
6.0	6.5	11.8	4.5	6.0	5.0	5.5	5.5
6.5	7.0	12.7	5.0	6.5	5.5	6.0	6.0
7.0	7.5	13.6	5.0	7.0	5.5	6.5	6.5
7.5	8.0	14.5	5.5	7.0	6.0	7.0	7.0
8.0	8.5	15.4	6.0	7.5	6.5	7.5	7.5
8.5	9.0	16.4	6.0	8.0	6.5	7.5	7.5
9.0	10.0	18.2	6.5	9.0	7.5	8.5	8.5
10.0	11.0	20.0	7.0	10.0	8.0	9.0	9.0
11.0	12.0	21.8	7.5	11.0	8.5	10.0	10.0
12.0	13.0	23.6	8.0	11.5	9.0	10.5	10.5
13.0	14.0	25.4	8.5	12.0	9.5	11.0	11.0
14.0	15.0	27.3	9.0	12.5	10.0	11.5	11.5
15.0	16.0	29.0	9.5	13.5	10.5	12.0	12.5
16.0	17.0	30.9	10.0	14.0	11.0	12.5	13.0
17.0	18.0	32.7	10.5	14.5	11.5	13.0	13.5
18.0	19.0	34.5	10.5	15.0	12.0	13.5	14.5
19.0	20.0	36.4	11.0	15.5	12.5	14.5	14.5

CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

STANDARD TITLE BLOCK FOR SUBDIVISION PLANS

SS-B1

ADOPTED: 10/15/02



(NOT TO SCALE)

GENERAL NOTES

1. All construction shall be done in accordance with the latest addition of the "City of Battlefield Design Standards for Public Improvements" and the "Missouri Standard Specifications for Highway Construction", unless otherwise noted.
2. Prior to beginning construction, a pre-construction conference must be held with the City of Battlefield. It is the Developer's responsibility to schedule this conference.
3. Prior to beginning construction, a grading permit must be obtained from the City of Battlefield. It is the Developer's responsibility to obtain this permit.
4. For sites where five (5) or more acres will be disturbed, a general permit for land disturbance activity must be obtained from the Missouri Department of Natural Resources before construction can begin. It is the Developer's responsibility to obtain this permit.
5. Other permits may be required for this construction. It is the Contractor's responsibility to determine which permits are applicable and to obtain any applicable permits not provided by the Developer.
6. If the Contractor's operations require work on or access across private property, it is the Contractor's responsibility to obtain written permission from the property owner to enter the property and to repair any damage to private property caused by his operations.
7. At the start of construction, or whenever work has been suspended, the Contractor shall contact the City of Battlefield (Phone 417-883-5840) at least wenty-four (24) hours prior to working at the site. Failure to do so may result in rejection of any work completed prior to contact.
8. The Contractor shall keep the subdivision neat and orderly at all times while construction is in progress. Access streets to the development shall be kept clean of mud, debris, paper and waste material at all times.
9. Construction access to the site shall be limited to the approved temporary construction entrance(s) shown on the Sediment & Erosion Control Plan (SECP).
10. Existing underground utilities will be shown by the Engineer in approximate locations as determined by existing plans and surface observations. It is the Contractor's responsibility to determine the exact horizontal and vertical location of existing underground facilities prior to beginning installation of new facilities. Contractor shall immediately contact the Engineer for instructions whenever any conflicts are discovered.
11. It is the Contractor's responsibility to correct any damage to underground utilities or other facilities which is caused by his operations.
12. Manhole covers, valve boxes, and other utility appurtenances shall not encroach on sidewalks, curbs or pavement. Where conflicts are discovered, the Contractor shall contact the Engineer for instructions prior to proceeding.
13. All disturbed areas shall be stabilized in accordance with the approved Sediment & Erosion Control Plan (SECP).

SUMMARY TABLE FOR STORM DRAIN PIPE & CHANNEL DESIGN

Project: | Date: | By: | Design Storm:

Inlet\Structure Number	Upstream invert elevation	Downstream invert elevation	Pipe\Channel Lining material	Pipe\channel length (%)	Pipe\channel Slope(%)	Manning's coefficient, n	Contributing drainage areas	Time of concentration (min)	Rainfall intensity (in\hour)	Design flow rate (cfs)	Minimum allowable slope (%)	Pipe friction loss (ft)	Hydraulic grade downstream	Full flow velocity (ft\sec)	V^2\2g	Structure head loss coefficient	Head loss at structure	Hydraulic grade upstream

FIGURE SS-B3

SUMMARY TABLE FOR INLET CALCULATIONS

Project: | Date: | By:

						MINOR STORM (2-YEAR)										DESIGN STORM (25-YEAR)					
InletRef. Point Number	Inlet Type	Inlet Grade	Drainage Area (Acres)	Runoff coefficient, C	Time of Concentration	2-year rainfall intensity (in/hr)	2-year peak flow rate (cfs)	Add bypass flow (cfs)	Bypass from	Total 2-yr. Flow Q2 (cfs)	Spread (feet0	Allowable Spread (ft.)	Q2 intercepted (cfs)	Q2 bypass flow (cfs)	Bypass to	25-year peak flow rate (cfs)	Add bypass flow (cfs)	Total 25-year flow (cfs)	Q25 intercepted (cfs)	Q25 bypass flow (cfs)	Q100 (cfs)

FIGURE SS-B4

RECOMMENDED NOTES FOR SEDIMENT & EROSION CONTROL PLAN

This plan shows the location and details for primary sediment controls to be constructed. The contractor is responsible for controlling erosion and discharge of sediment from the site at all times during construction. The contractor shall provide necessary measures during all phases of his operations regardless of whether they are specifically noted on this plan and shall maintain and replace controls as necessary during the course of his operations.

Temporary construction entrance(s) and silt fences, straw bale dikes or other initial sediment controls shown on this plan must be installed prior to any other work.

Sediment basins shown on this plan must be installed within 10 calendar days after construction begins or as soon as 2 or more acres are disturbed, whichever occurs first.

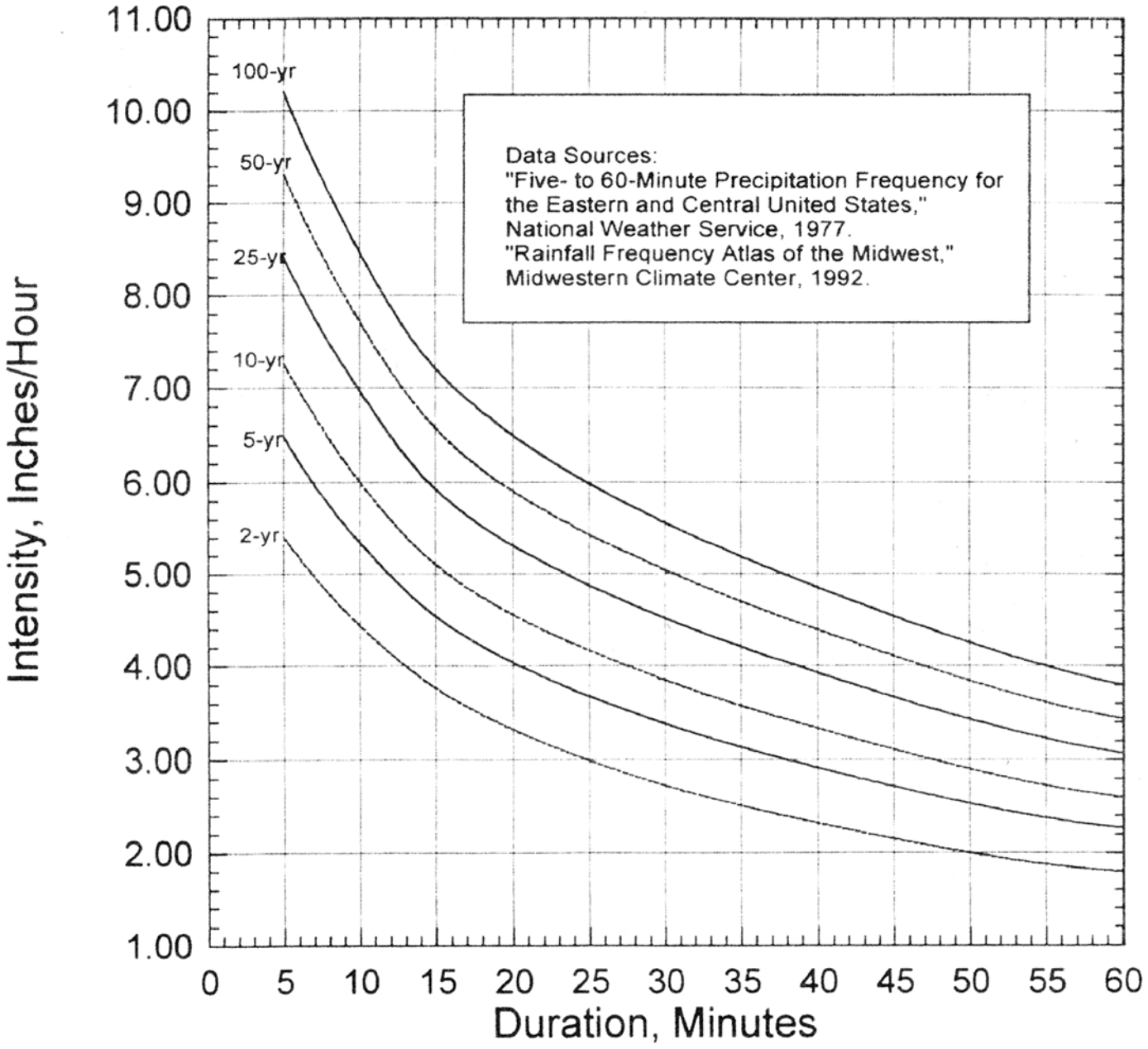
The contractor shall clean streets both interior and adjacent to the site, as needed after each rainfall, and at the end of construction.

The contractor is responsible for controlling dust during construction and shall water construction areas whenever conditions warrant.

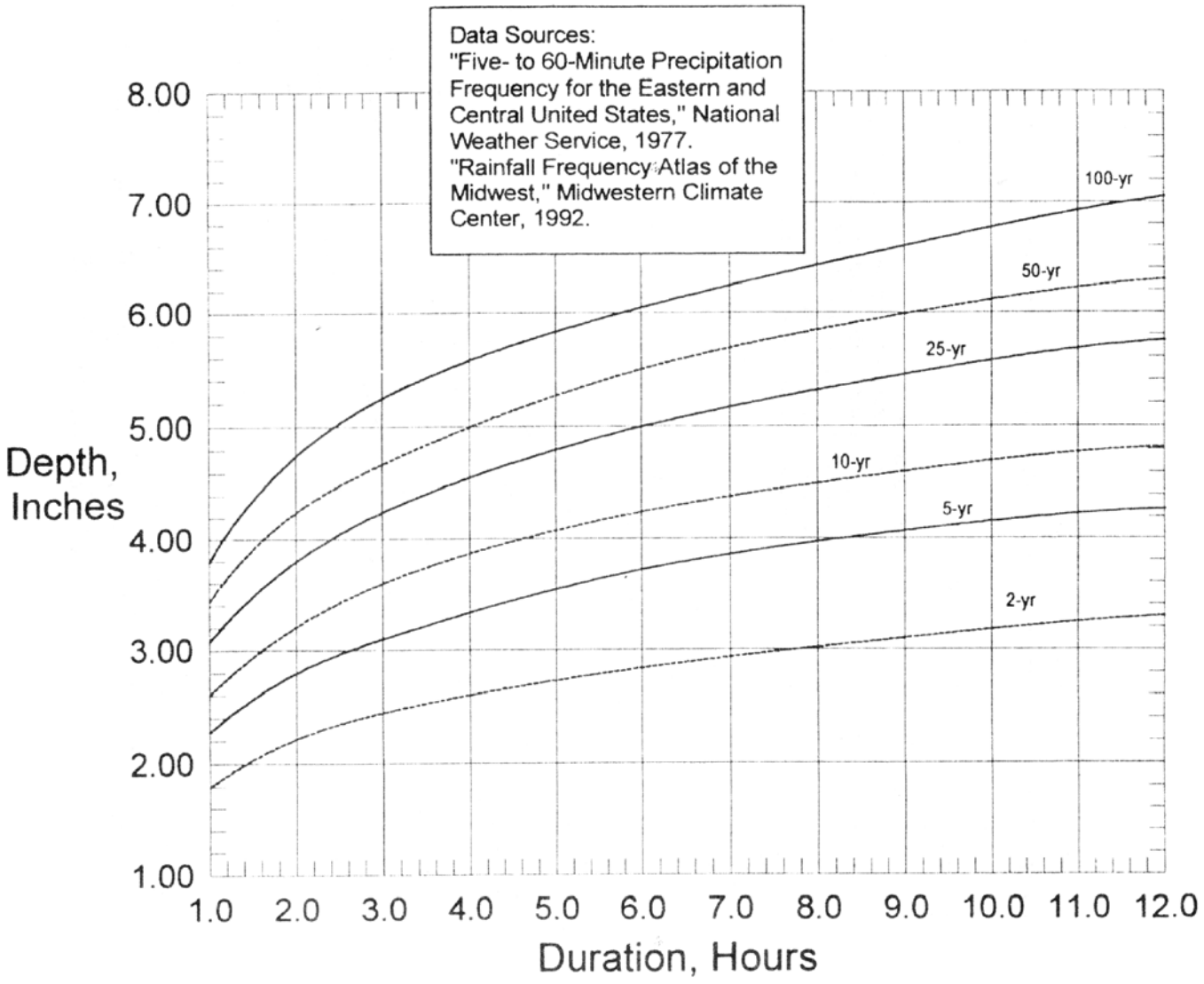
The contractor is responsible for cleaning accumulated sediment from storm drains prior to approval of construction.

All disturbed areas not receiving other permanent stabilization such as pavement, roofs, sod, etc., shall be seeded and mulched, as specified below before temporary sediment controls can be removed and prior to final approval of construction.

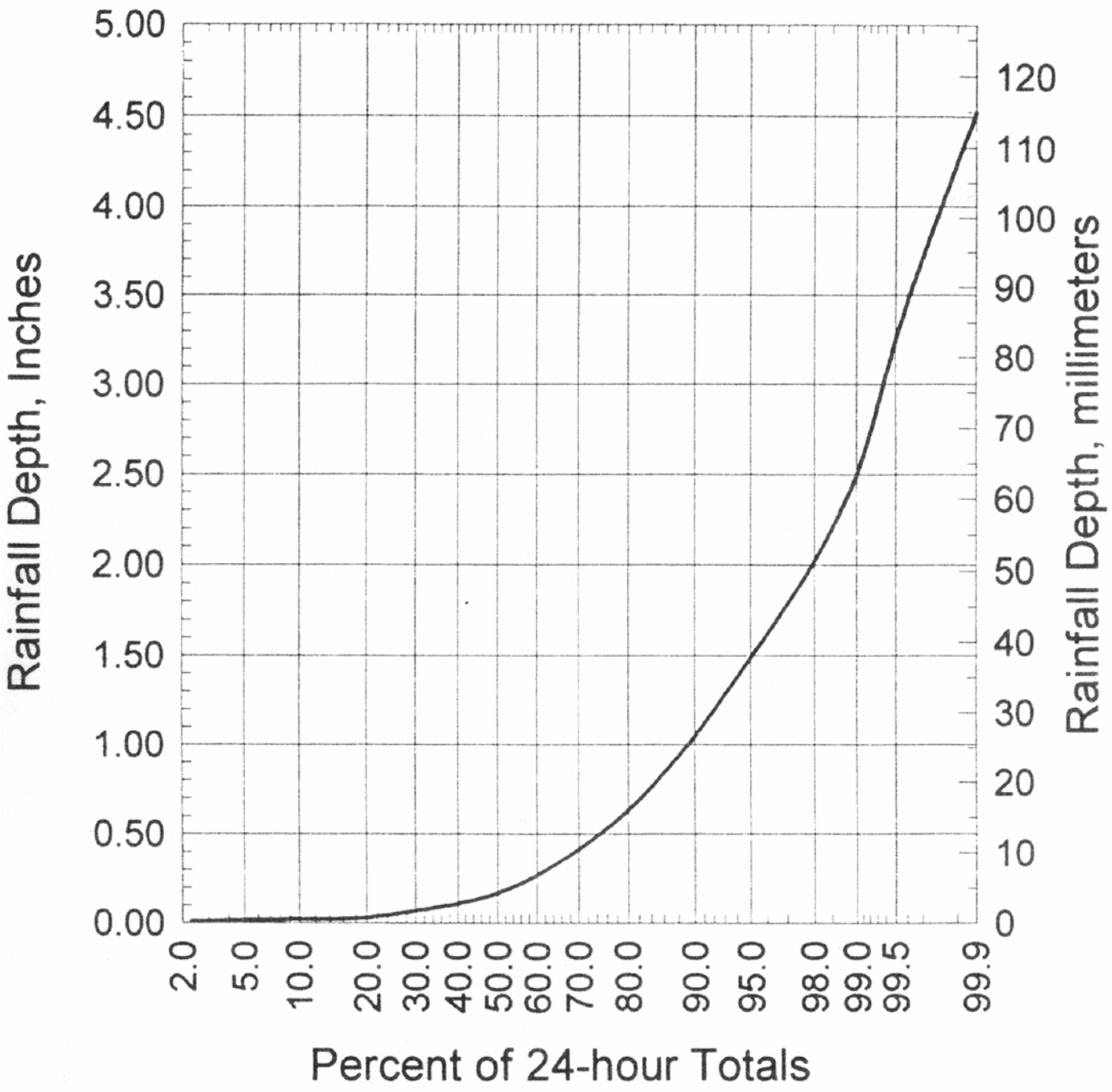
- A minimum depth of 4" of topsoil (prior to compacting) shall be spread on areas to be seeded.
- After topsoil is spread, line shall be spread at the rate of 800-900 pounds, effective neutralizing material (ENM) per acre.
- Fertilizer shall be spread at the rate of 400-500 pounds per acre, and shall be 13-13-13 nitrogen, phosphorus, and potassium.
- Seed mix shall consist of 60-80% Kentucky 31 tall fescue and 20-40% annual ryegrass (germination shall be at least 85%). Seed mix shall be spread at the rate of 400-500 pounds per acre.
- All areas to be seeded having slopes less than 4:1 shall be mulched with cereal grain mulch the rate of 100 pounds per 1000 square feet (4500 pounds per acre). Cereal grain mulch shall meet the requirements of Section 802 of the State Specifications for Type 1 mulch. Mulch may be applied by hand, however, it must be evenly spread. Type 1 much shall be thoroughly wetted immediately after application.
- Where slopes are 4:1 or greater Type 3 mulch ("hydromulch") meeting the requirements of Section 802 of the State Specifications shall be used. Type 3 mulch shall be applied at the rate of 2000 pounds per acre.
- Permanent seeding season runs from March 1st to June 1st and August 15th to November 1st. Seeding and mulching must be done whenever work is complete regardless of the season. Whenever seeding and mulch is installed outside of the permanent seeding season the contractor will be responsible for replanting and mulching any areas where growth has not become established during the next permanent seeding season.
- All areas must be maintained by the contractor until vegetation is firmly established. Vegetation will be considered firmly established when it has survived from the permanent seeding season in which it is placed, to the next permanent seeding season, and growth has been established on all eroded areas which have been noted for repair.
- Temporary seeding shall be at the same rates for seed, mulch and fertilizer specified above. Topsoil spreading is not required in areas designated to receive temporary seeding only.



CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	RAINFALL IDF CURVE 5 – 60 MINUTES	ADOPTED: 10/15/02 SS–C1

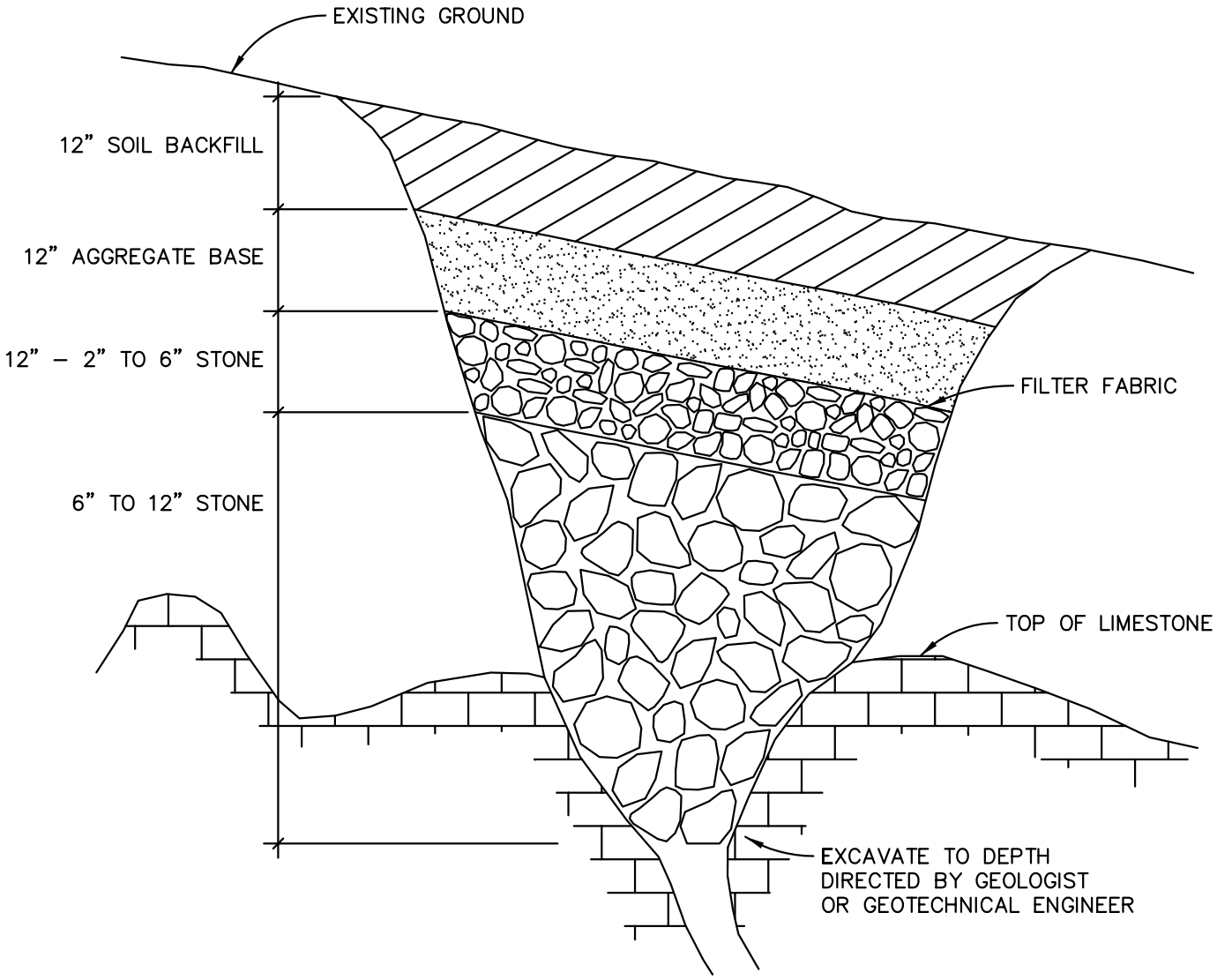


CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	RAINFALL IDF CURVE 1 – 12 HOURS	ADOPTED: 10/15/02 SS–C2



National Weather Service, Hourly Precipitation, Springfield, Missouri.
Period of record January 1958 - December 1994.

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	RAINFALL DEPTH vs. % OF 24 HOUR TOTALS	ADOPTED: 10/15/02 SS-C3



CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	SINKHOLE COLLAPSE STABILIZATION	ADOPTED: 10/15/02 SS–D1

ALLOWABLE FLOODING DEPTHS FOR STREETS AND PARKING LOTS

A. PUBLIC AND PRIVATE STREETS

1. MINOR/CONVENIENCE STORM: 2 year storm

On grades:

Local streets: No crown overtopping
Collector streets: No overtopping, center 10' of street
Secondary arterials: Two - 10' lanes must remain open;
(T = 7.5' for 36'-wide street)
Arterial streets : Flow limited to width of gutter (T=2')

In sumps:

Local streets: Depth shall not exceed top of curb
Collector streets: Depth shall not exceed top of curb
Secondary arterials: Two - 10' lanes must remain open;
(Maximum spread, T = 7.5')
Arterial streets: Flow limited to width of gutter (T=2')

2. MAJOR/EMERGENCY STORM

On grades:

All classifications: Limit 25-year storm to top of curb
Limit 100-year storm to right-of-way
Maximum depth, 100-year storm = 18" at face of curb.

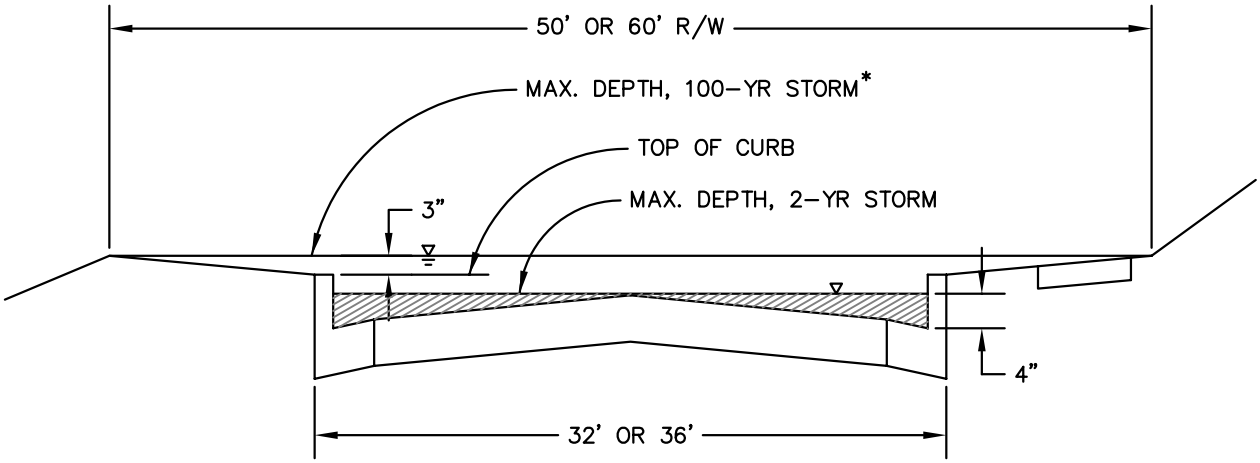
In sumps:

All classifications: Limit 25-year storm to right-of-way
Maximum depth, 100-year storm = 18" at face of curb.

B. PARKING LOTS & PRIVATE DRIVES

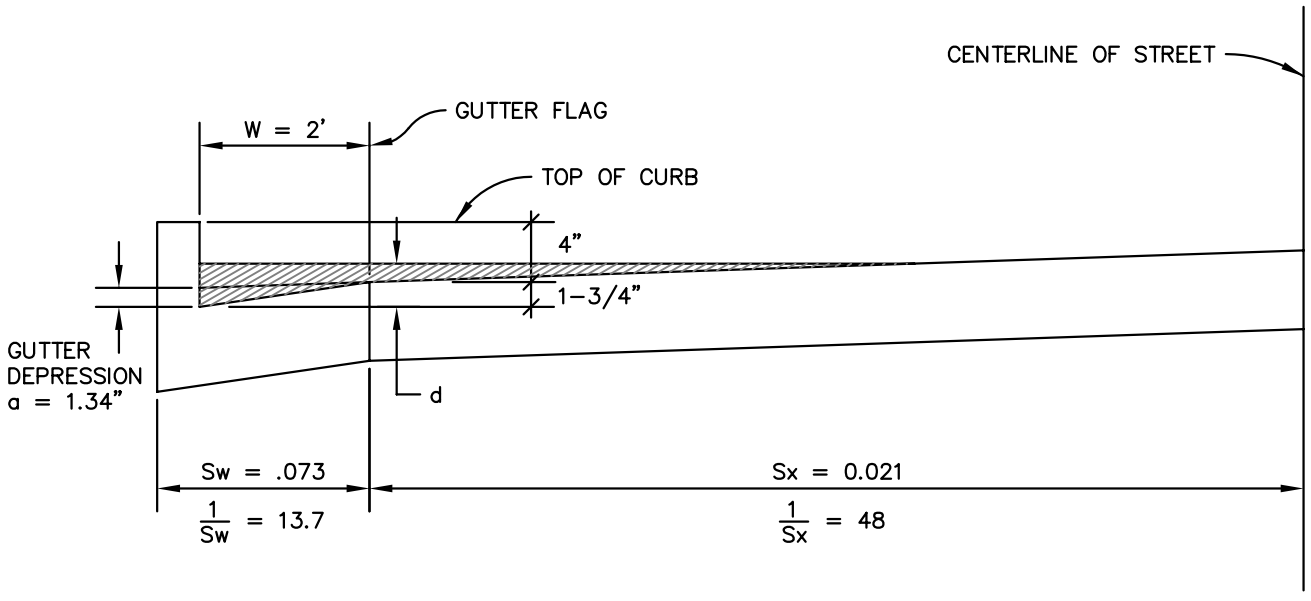
1. MINOR/CONVENIENCE STORM - no requirements.

2. MAJOR/EMERGENCY STORM - depth shall be limited to 18" measured from the top of the grate or from the bottom of a vertical inlet opening.



* IN SUMPS, KEEP Q_{25} IN R/W; MAX. DEPTH FOR Q_{100} IS 18" AT GUTTER (12" OVER TOP OF CURB)

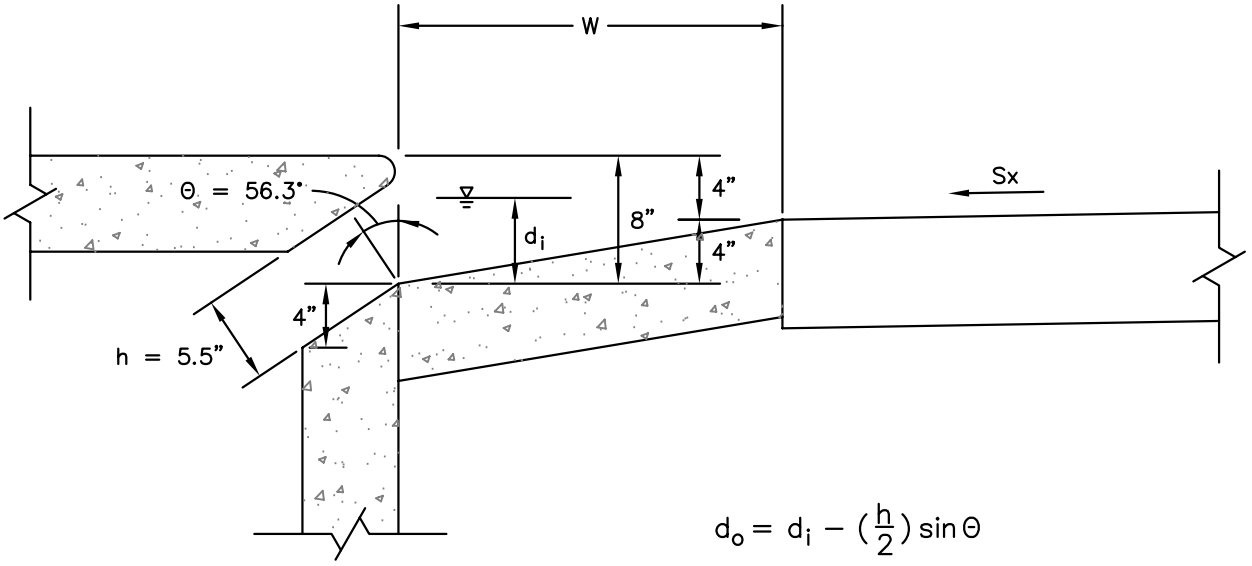
ALLOWABLE FLOODING DEPTHS – LOCAL STREET



$$Sw' = \frac{a}{12W} = 0.055, \quad \frac{1}{Sw'} = 18.2$$

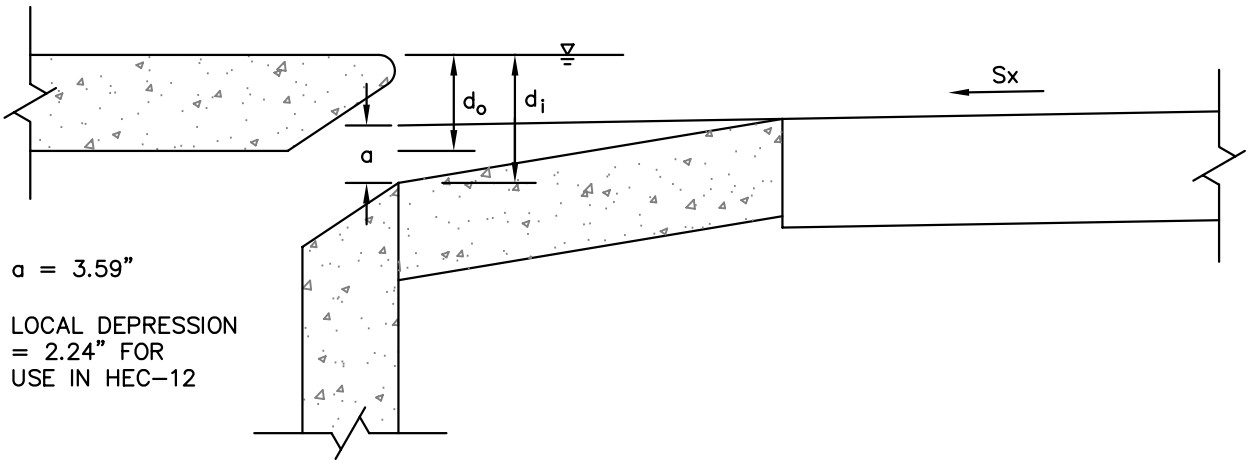
DEFINITION SKETCH – VARIABLES FOR GUTTER FLOW AND INLET DESIGN

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STREET FLOODING DEPTHS VARIABLE DEFINITIONS	ADOPTED: 10/15/02 SS-E3



$$d_o = d_i - \left(\frac{h}{2}\right)\sin\Theta$$

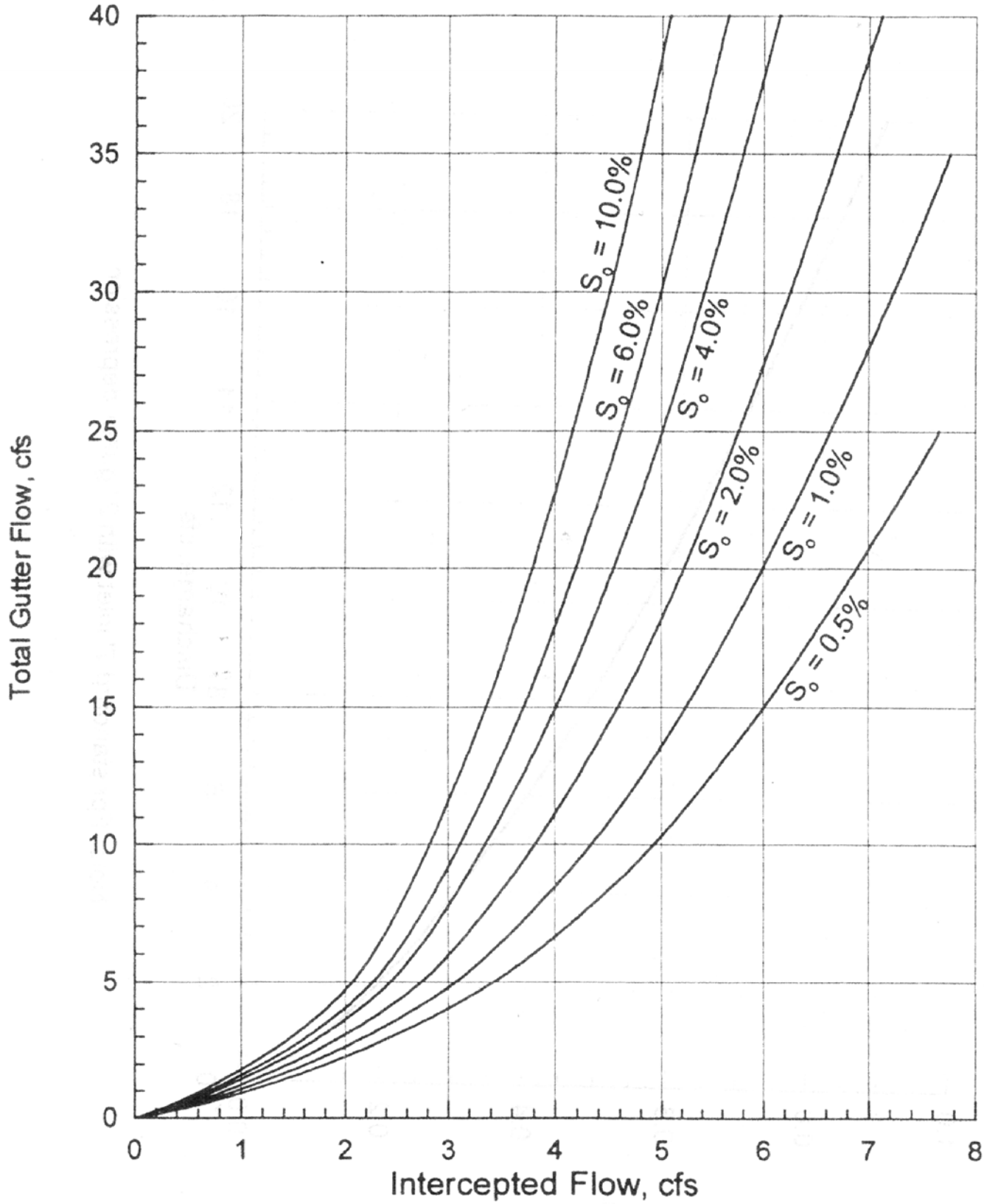
$$d_i = d + 2.24"$$



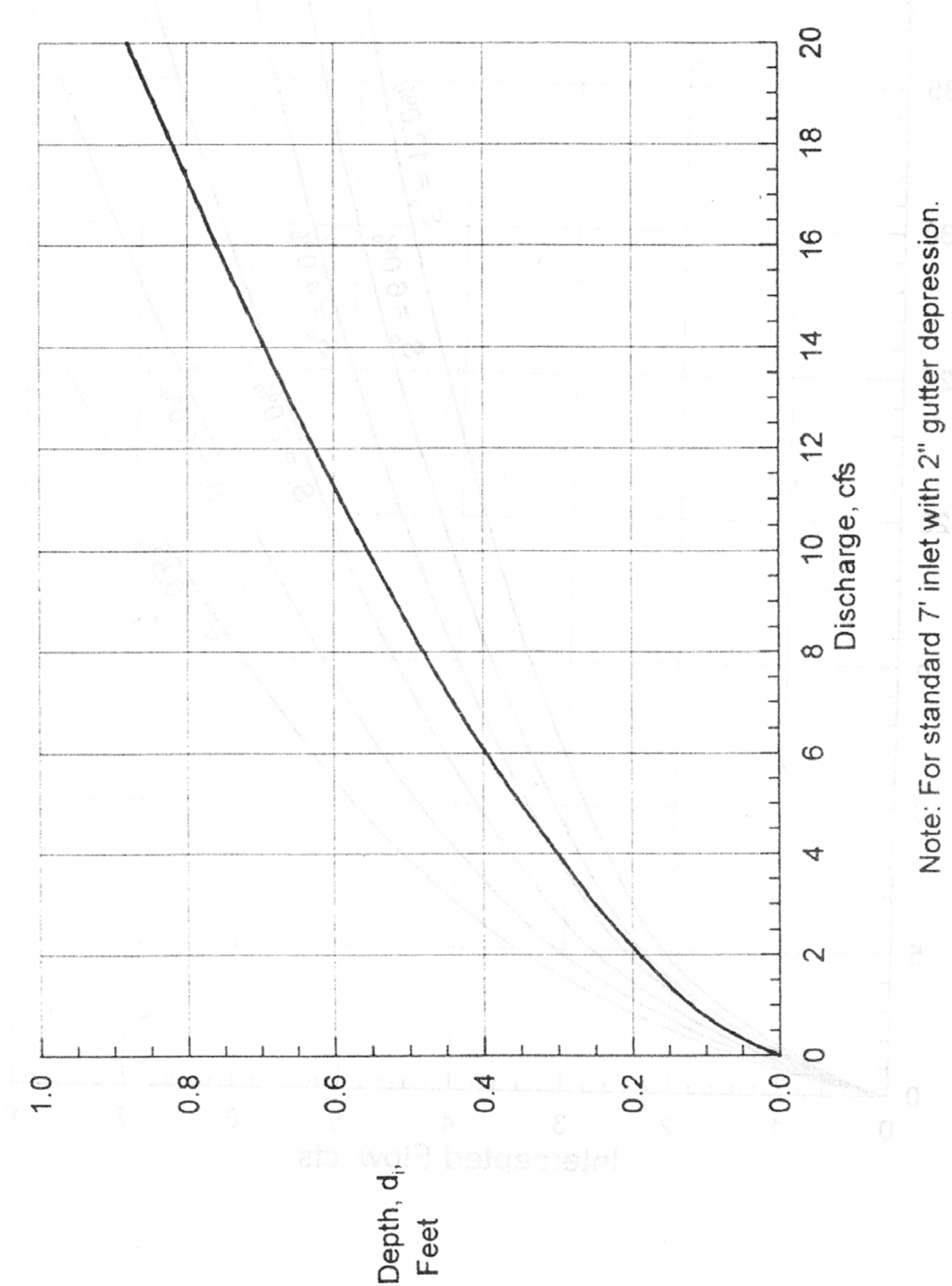
a = 3.59"

LOCAL DEPRESSION
= 2.24" FOR
USE IN HEC–12

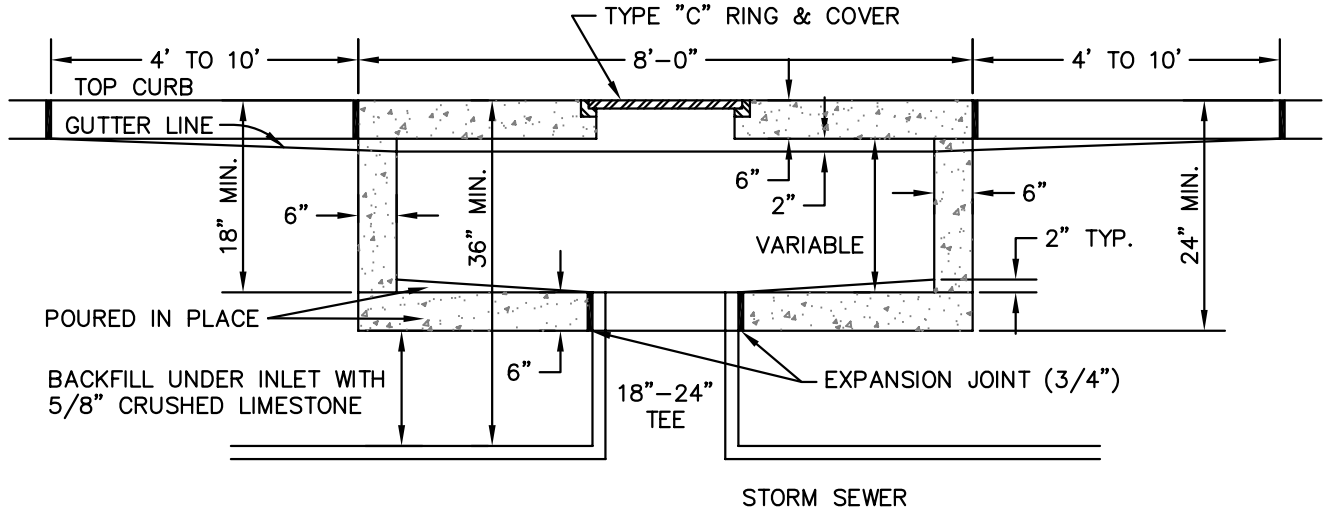
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	STANDARD CURB INLET DEFINITION SKETCH	ADOPTED: 10/15/02 SS–E4

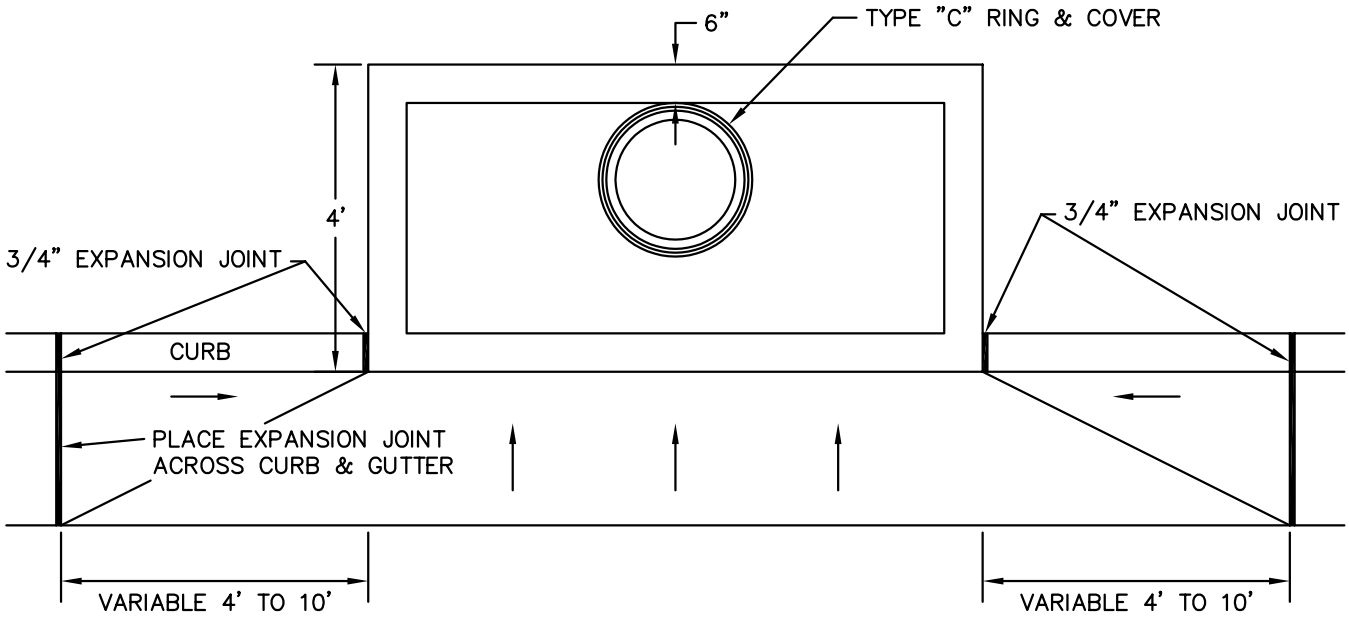


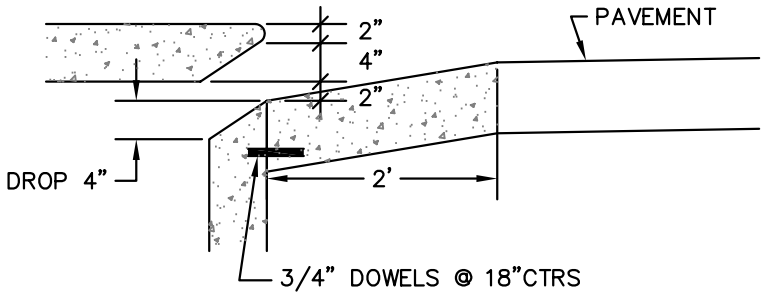
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD CURB INLET INTERCEPTION CAPACITY	ADOPTED: 10/15/02 SS–E5



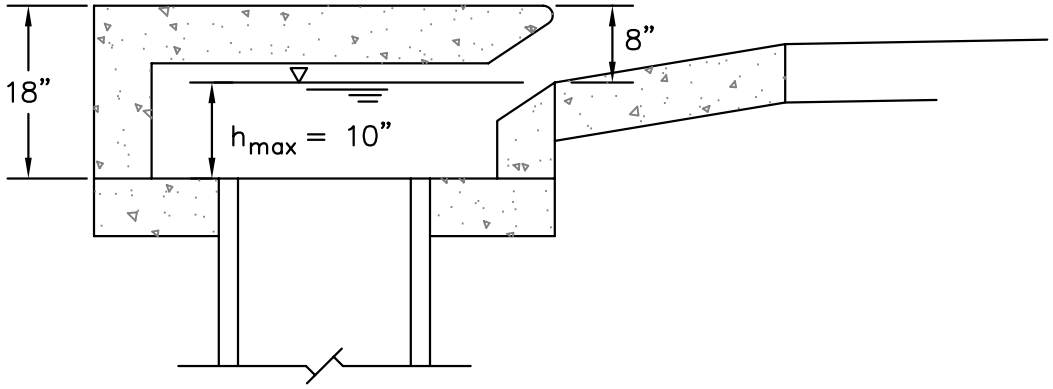
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD CURB INLET CAPACITY IN A SUMP	ADOPTED: 10/15/02 SS–E6







CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	SS-5 CURB OPENING INLET	ADOPTED: 10/15/02 SS-E7

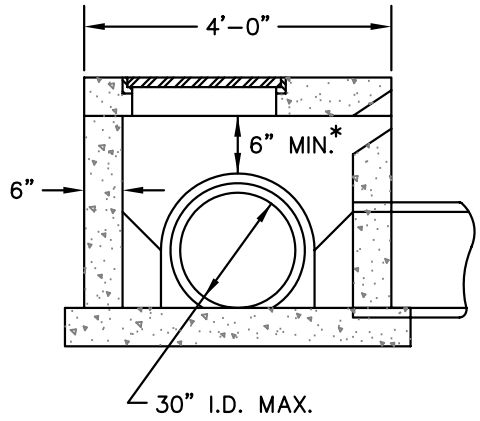


USE WEIR EQUATION $Q = Cw\ L\ h^{3/2}$

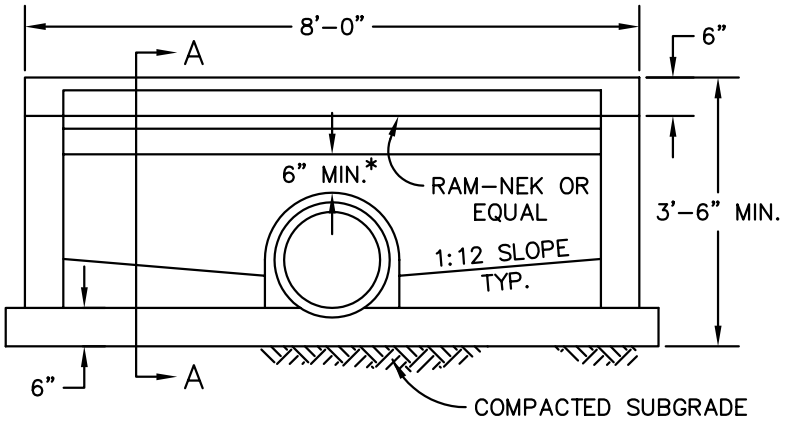
$Cw = 3.0$

L = Pipe Circumference

RISER DIAMETER (in.)	$L = \pi D$ (ft.)	Q_{max} (cfs)
18	4.7	10.7
21	5.5	12.5
24	6.3	14.4



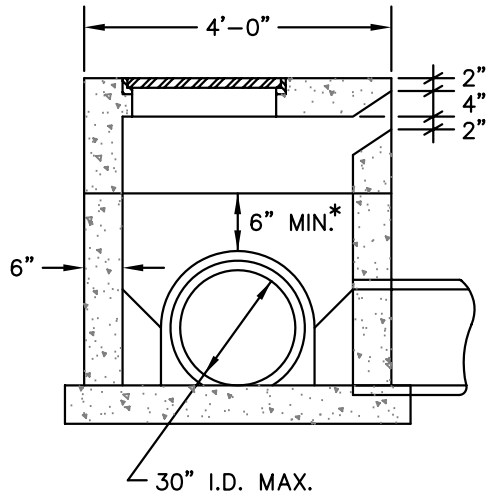
SECTION A–A



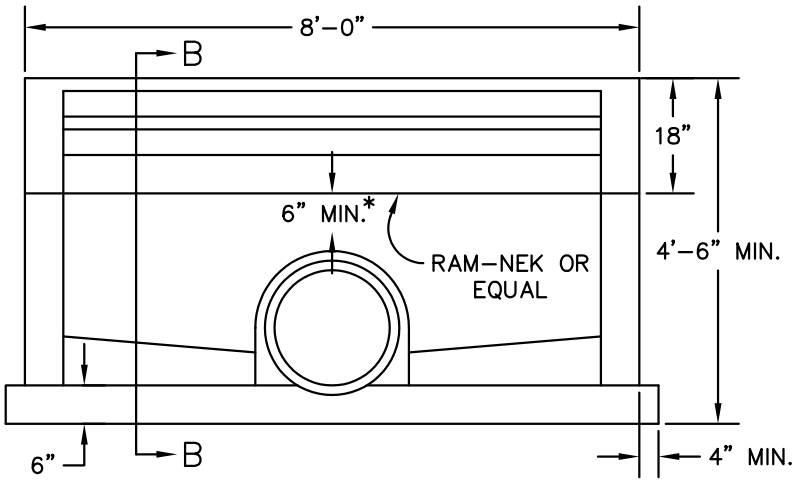
NOTE: #4 ø @ 10" C.C. (ALL WALLS, VERT. & HOR.)
SEE FIG. 108.10 FOR TOP SLAB REINFORCEMENT

6" PRECAST TOP

* NOTE: LESS CLEARANCE MAY BE ALLOWED PROVIDED ADEQUATE STRUCTURAL PROVISIONS ARE MADE TO PREVENT THE UNIT FROM CRACKING DURING DELIVERY AND INSTALLATION.



SECTION B–B



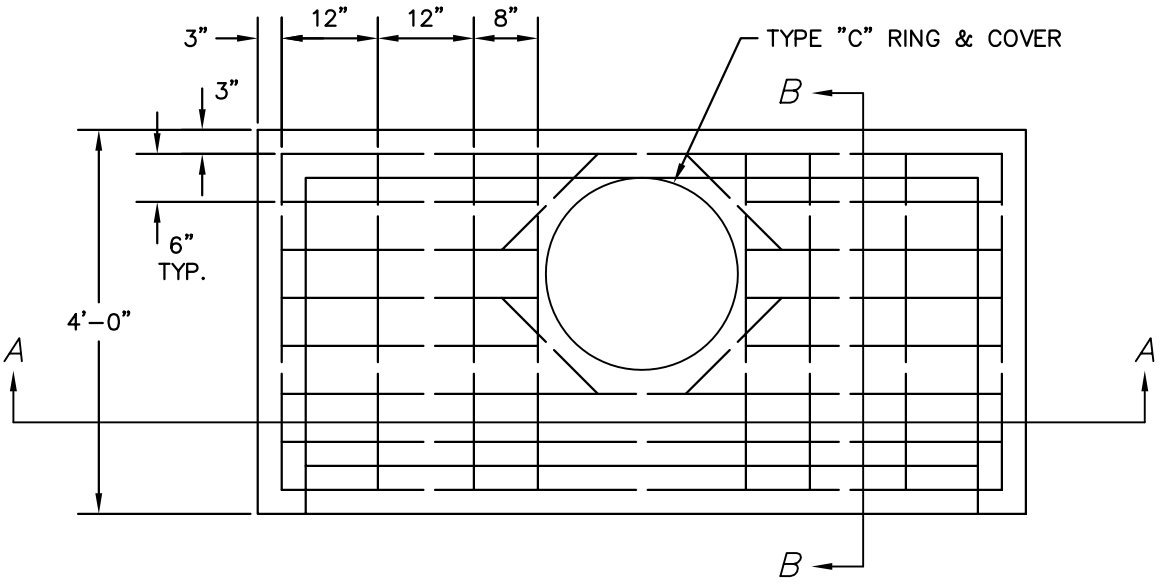
NOTE: #4 ø @ 10" C.C. (ALL WALLS, VERT. & HOR.)
SEE FIG. 108.10 FOR TOP SLAB REINFORCEMENT

18" PRECAST TOP

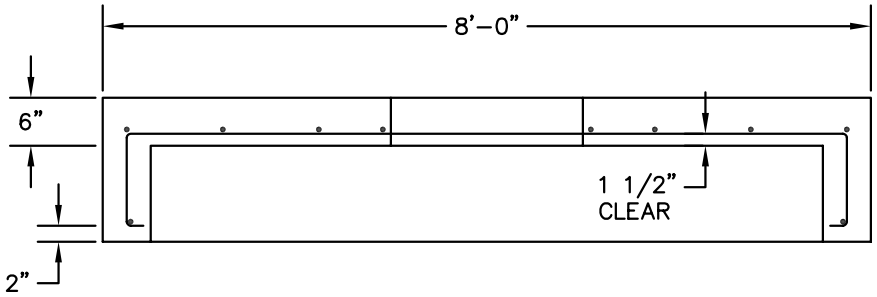
NOTES:

1. BOTTOM TO BE CAST IN PLACE.
2. PIPE TO BE ON GRADE BEFORE BOTTOM IS CONSTRUCTED.
3. FOR 6" TOP USE 4 – #4 ø DOWELS; ONE IN EACH CORNER W/ RAM–NEK OR EQUAL.
4. RAM–NEK ALL JOINTS (OR EQUAL).
5. 6" INVERT REQUIRED TO PREVENT SEDIMENTATION.

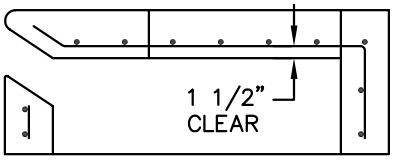
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	SS–6 CURB OPENING INLET	ADOPTED: 10/15/02 SS–E9



USE NO. 4 BAR THROUGHOUT



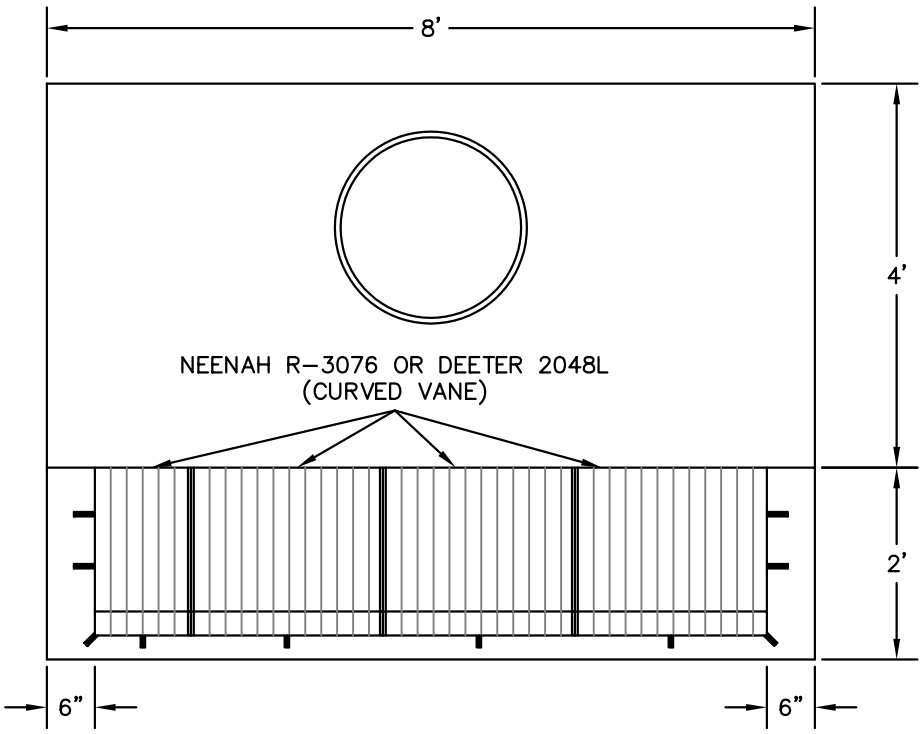
SECTION A–A



SECTION B–B

NOTE: "SS–8" TOP SHOWN, REINFORCEMENT FOR 6" "SS–6" TOP SIMILAR

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	TYPICAL REINF. FOR PRECAST INLET TOPS	ADOPTED: 10/15/02 SS–E10

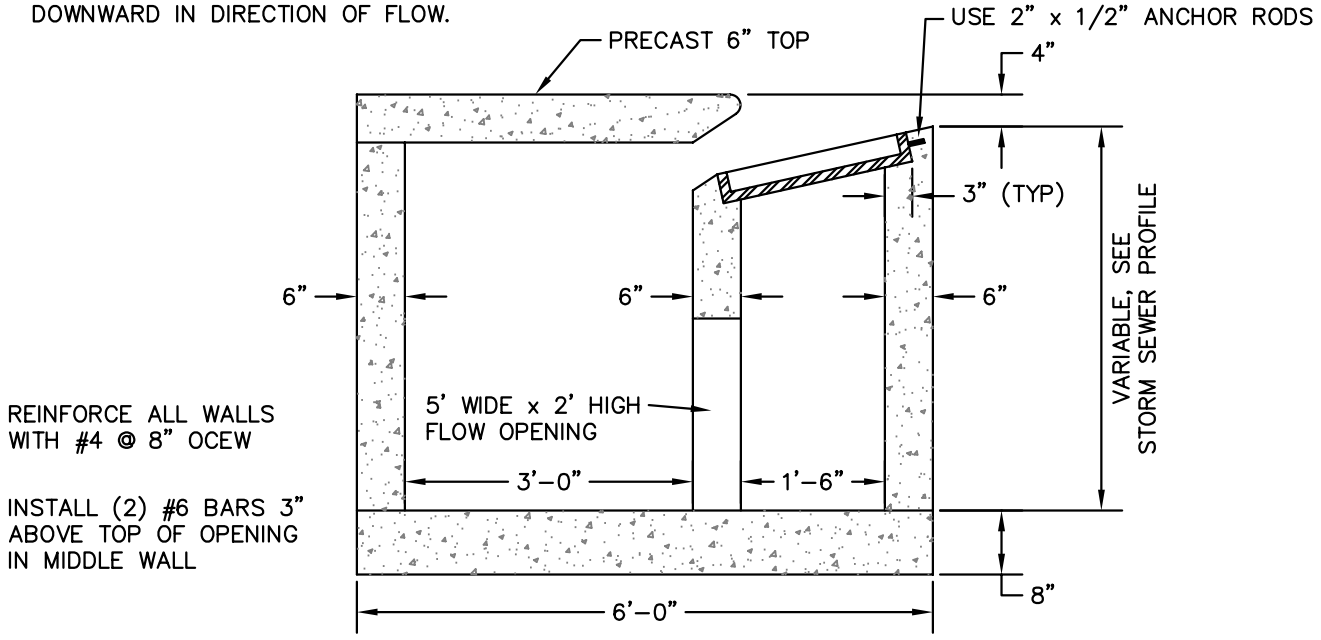


PLAN VIEW

NOT TO SCALE

NOTES:

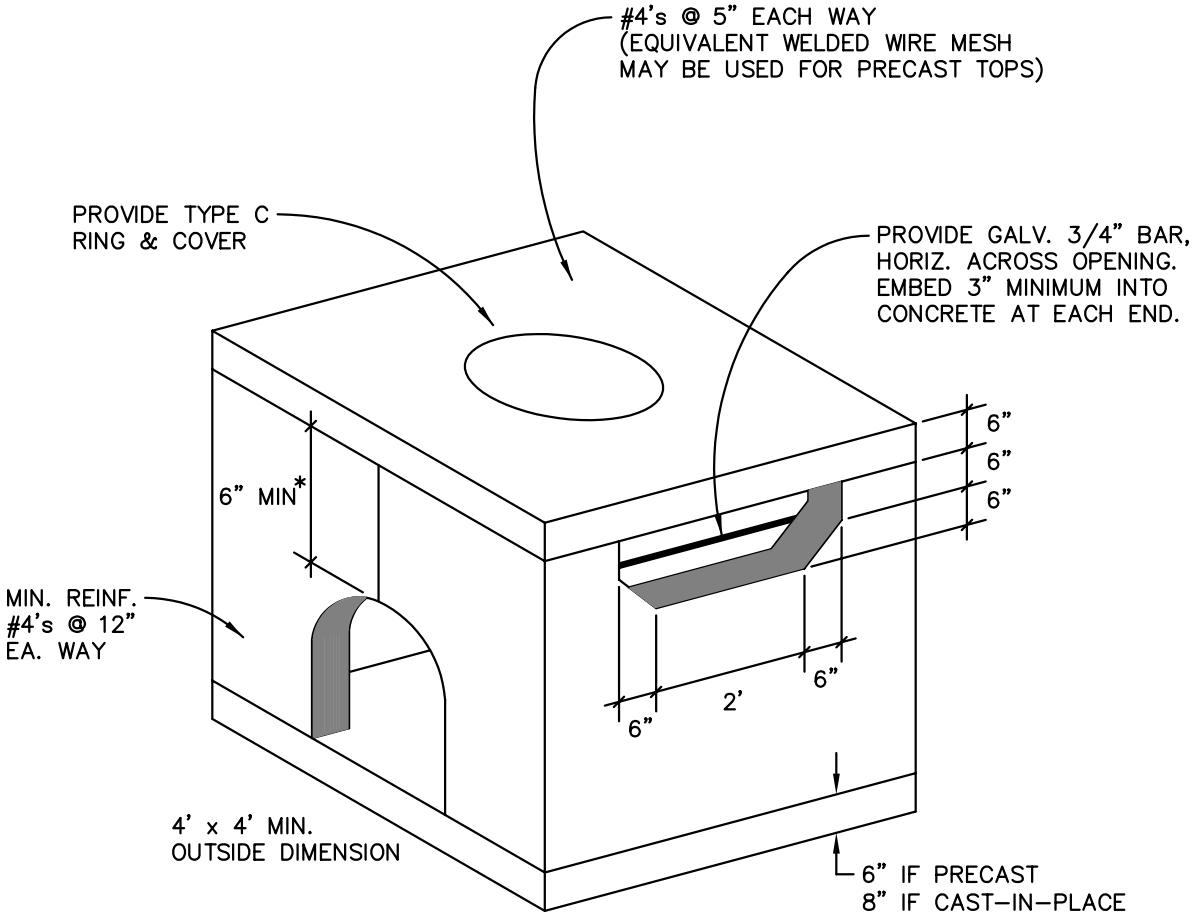
1. WHEN USED WITH NON-GRATE INLETS, PLACE GRATE INLET DOWNSTREAM.
2. PLACE GRATES SUCH THAT VANES CURVE DOWNWARD IN DIRECTION OF FLOW.



SECTION VIEW

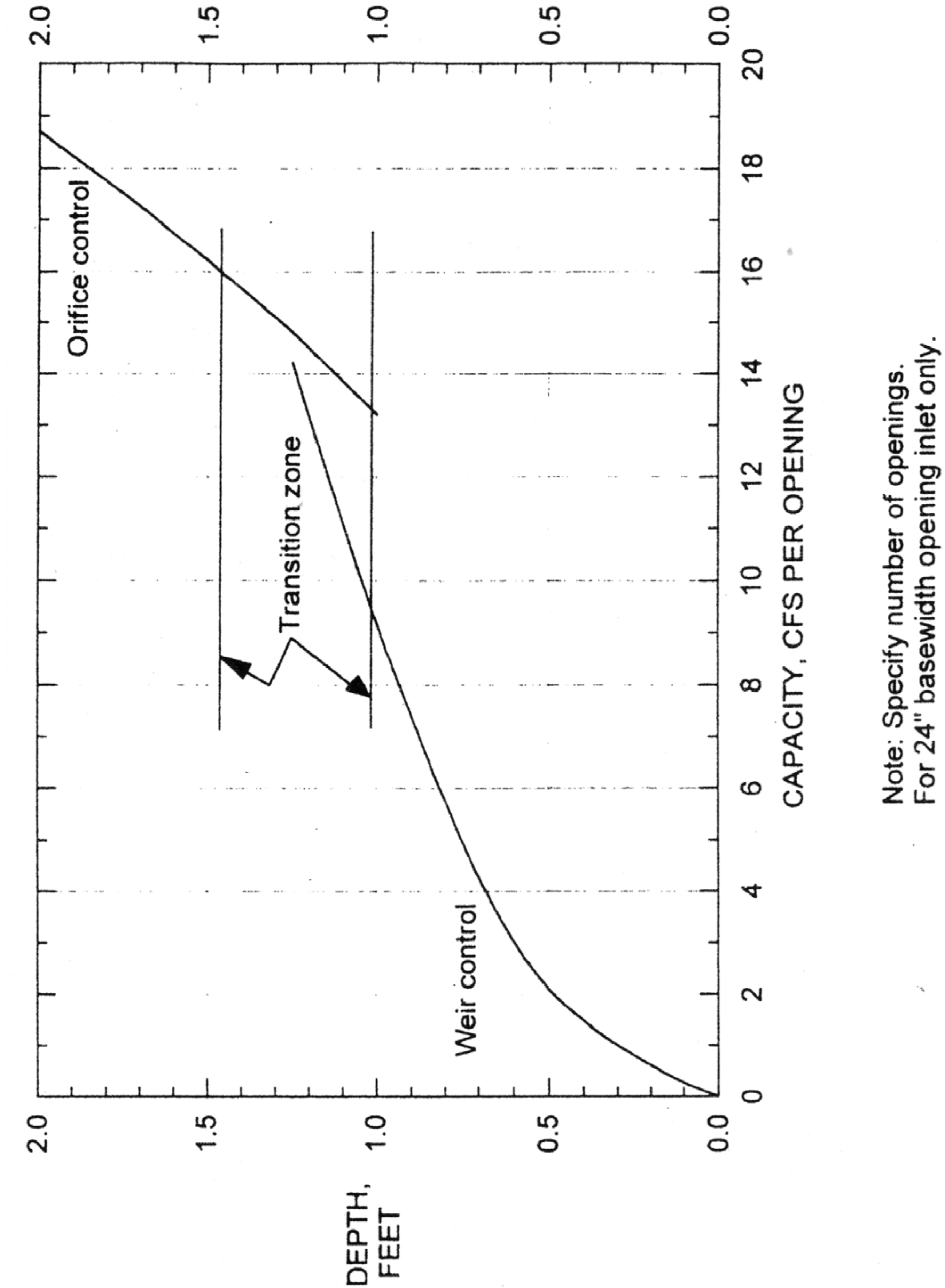
NOT TO SCALE

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD SS-6G INLET	ADOPTED: 10/15/02 SS-E11

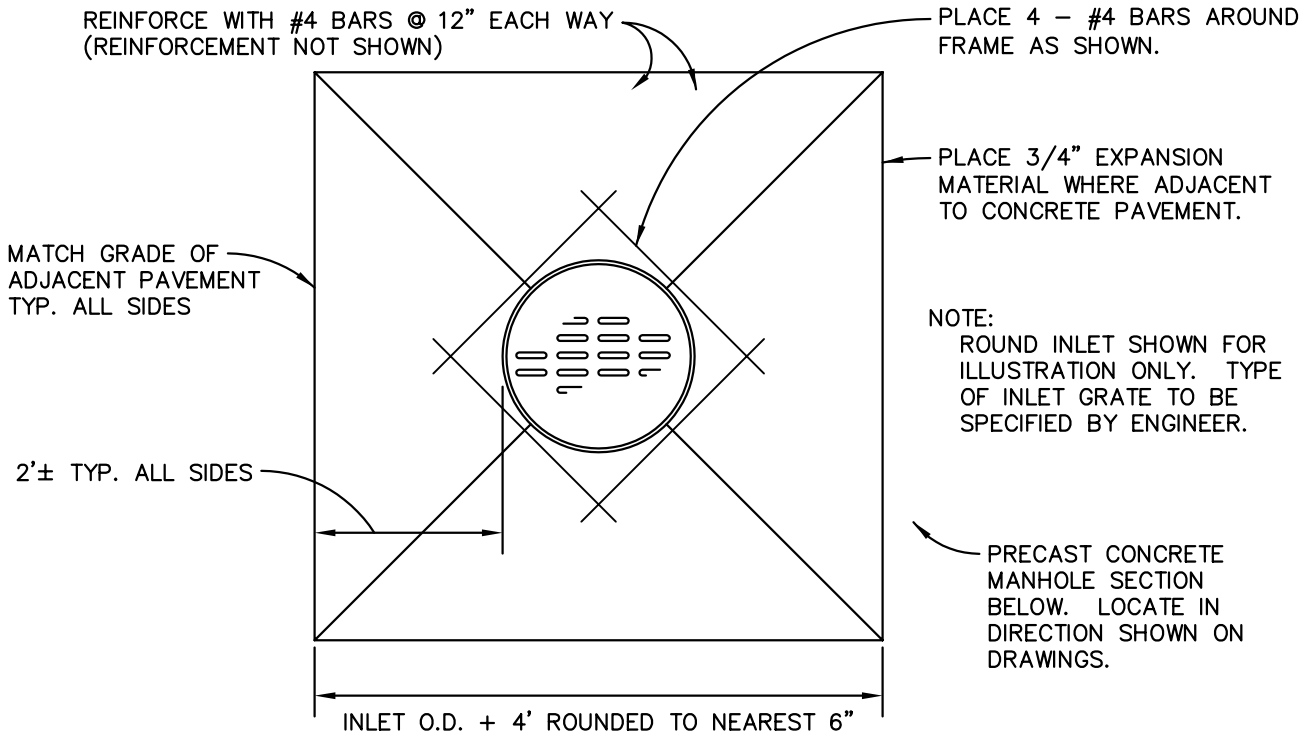


* LESS CLEARANCE MAY BE ALLOWED PROVIDED ADEQUATE STRUCTURAL PROVISIONS ARE MADE TO PREVENT THE UNIT FROM CRACKING DURING DELIVERY AND INSTALLATION.

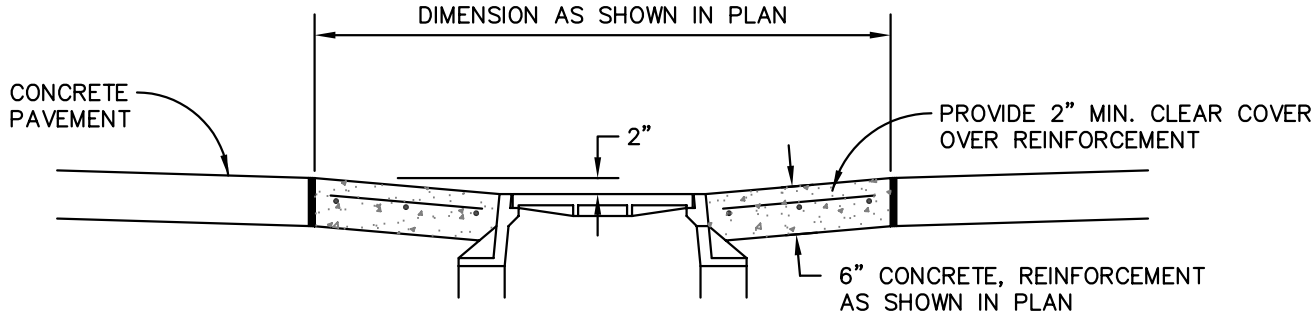
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	STANDARD DI-1 INLET	ADOPTED: 10/15/02 SS-E12



CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD DI-1 INLET CAPACITY	ADOPTED: 10/15/02 SS-E13

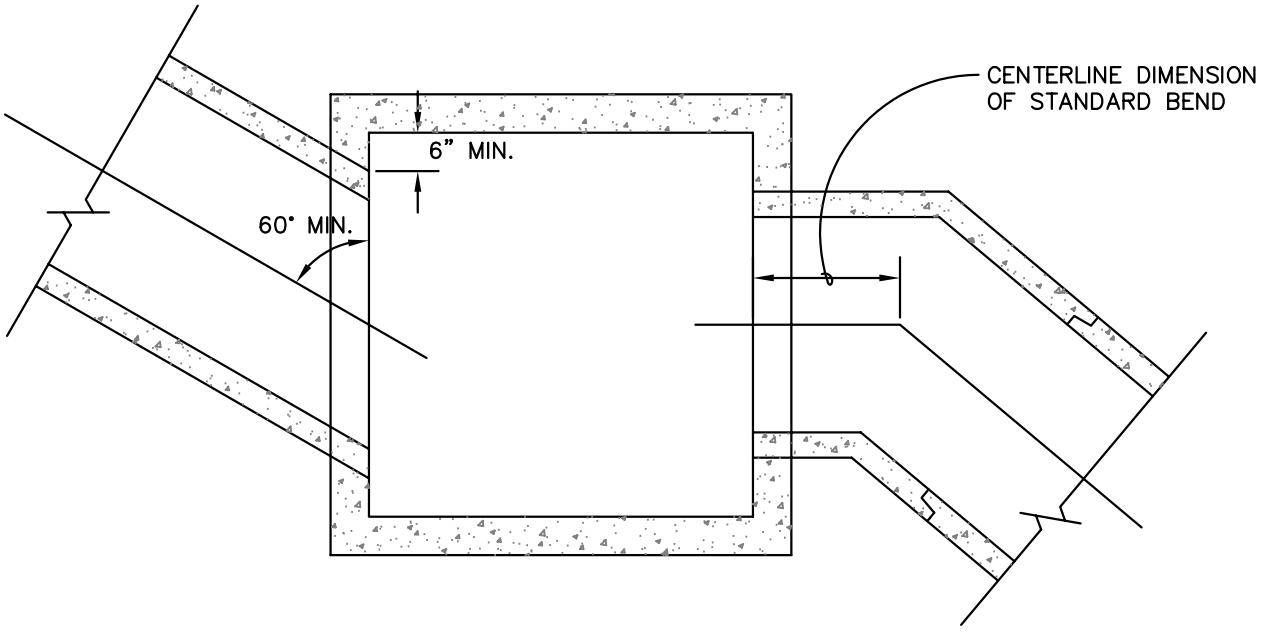


PLAN VIEW
NOT TO SCALE

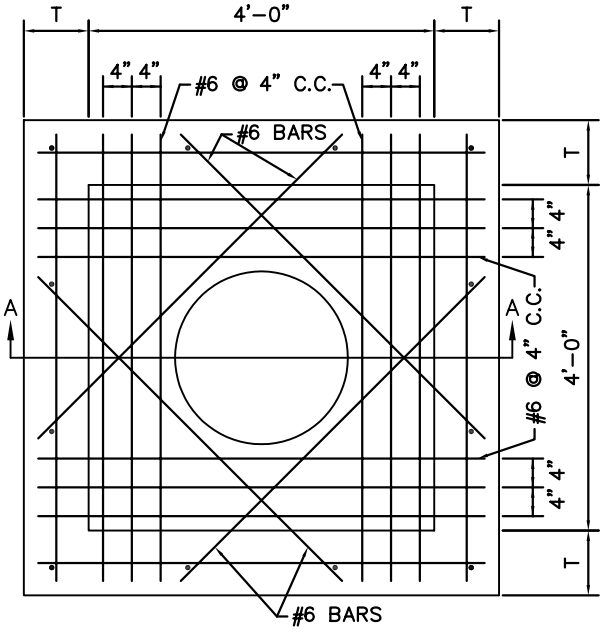


SECTION VIEW
NOT TO SCALE

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TYPICAL AREA INLET CONCRETE APRON	ADOPTED: 10/15/02 SS–E14



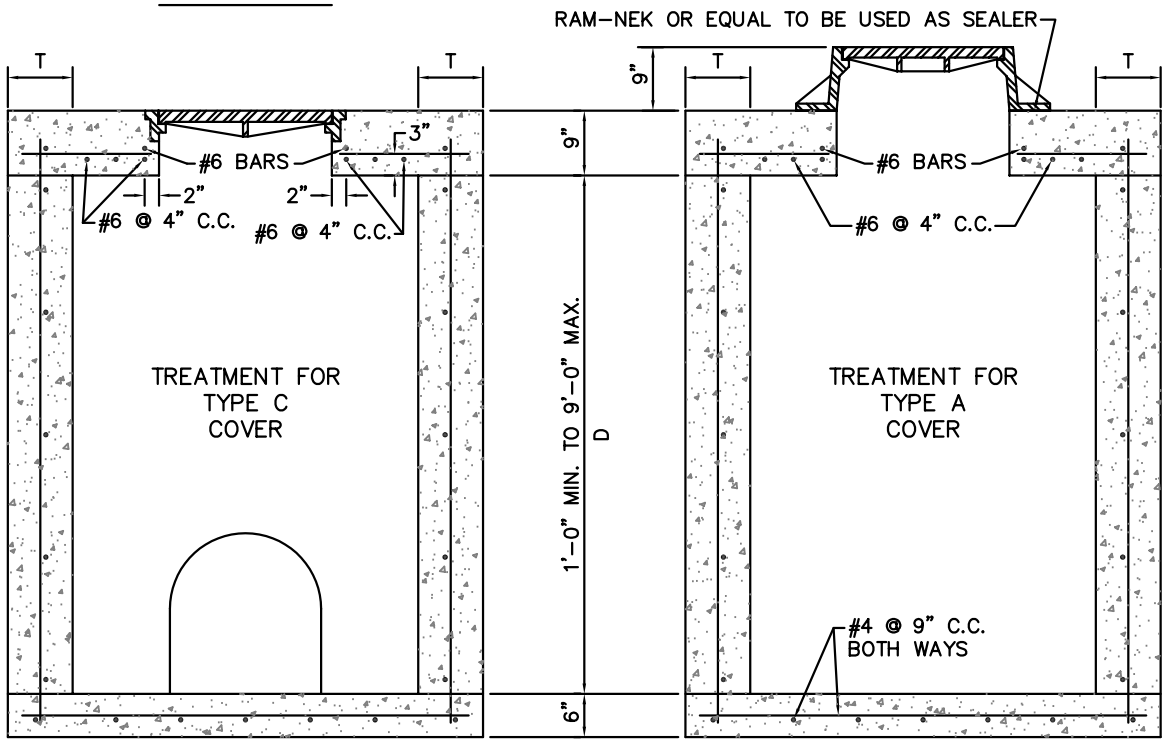
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TYP. PIPE CONNECTIONS @ JUNCTION STRUCTURES	ADOPTED: 10/15/02 SS–F1



PLAN

STANDARD JUNCTION BOX				
TABLE OF REINFORCEMENT			WALL THICK.	CONC.
"D"	VERT. BARS	HOR. BARS	"T"	CU. YDS.
1'-0"	NONE	NONE	9"	1.93
2'-0"	"	"	9"	2.45
3'-0"	"	"	9"	2.98
4'-0"	"	"	9"	3.50
5'-0"	12 #5 @ 18" C.C. 5'-11" EACH	20 #4 @ 14" C.C. 5'-2" EACH	9"	4.03
6'-0"	12 #5 @ 18" C.C. 6'-11" EACH	20 #4 @ 17" C.C. 5'-2" EACH	9"	4.55
7'-0"	20 #5 @ 12" C.C. 7'-11" EACH	24 #4 @ 16" C.C. 5'-2" EACH	9"	5.08
8'-0"	20 #5 @ 12" C.C. 8'-11" EACH	28 #4 @ 15" C.C. 5'-2" EACH	9"	5.61
9'-0"	20 #5 @ 12" C.C. 9'-11" EACH	28 #4 @ 17" C.C. 5'-2" EACH	9"	6.14

STEEL IN TOP SLAB 16 #6 5'-2" EACH
4 #6 5'-0" EACH
STEEL IN BOTTOM 14 #4 5'-2" EACH
SEE DRAWINGS FOR STEEL PLACEMENT



SECTION AA

1. DIAGONAL BARS IN TOP SLAB PLACED NEAR BOTTOM OF SLAB.
2. REINFORCING BARS SHALL BE CUT OR BENT AT PIPE OPENINGS.
3. ALL PIPES SHALL FIT FLUSH WITH INSIDE FACE OF BOX.
4. MAXIMUM PIPE SIZE FOR BOX IS 42". FOR LARGER PIPES INCREASE INSIDE BOX DIMENSIONS TO THE INSIDE PIPE DIAMETER PLUS 6". USE GIVEN BAR SPACING FOR LARGER BOXES. MAXIMUM ALLOWABLE BOX SIZE IS 72".
5. BOTTOM OF BOX TO BE FILLED WITH CONCRETE TO MID-DEPTH OF PIPE FORMING CHANNELS TOWARD OUTLET PIPE FROM ALL INLET PIPES.
6. ALL CONCRETE SHALL HAVE 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI
7. ALL REINFORCING BARS TO BE DEFORMED BARS AND MEET REQUIREMENTS OF ASTM A-615 MIN. GRADE 40.
8. 4" BEDDING MATERIAL TO BE USED UNDER BOX.
9. IF BOX IS GREATER THAN 9', MUST BE SPECIAL DESIGN.

FULL FLOW DATA FOR CIRCULAR PIPE

D Pipe Diameter (inches)	A Area (Square feet)	R Hydraulic Radius (feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2a3}$	
			n=0.013	n=0.024
4	0.0873	0.083	1.9	---
6	0.196	0.125	5.6	---
8	0.349	0.167	12.1	---
10	0.545	0.208	21.8	---
12	0.785	0.250	35.7	26.3
15	1.227	0.312	64.7	35.0
18	1.767	0.375	105	56.9
21	2.405	0.437	158	85.6
24	3.142	0.500	226	122
27	3.976	0.562	310	167
30	4.909	0.625	410	222
36	7.069	0.750	666	360
42	9.621	0.875	1006	545
48	12.566	1.000	1436	778
54	15.904	1.125	1967	1065
60	19.635	1.250	2604	1414
66	23.758	1.375	3357	1818
72	28.274	1.500	4234	2293
84	38.485	1.750	6388	3460
96	50.266	2.000	9119	4439

FROM: **American Concrete Pipe Association, 1985**
"Concrete Pipe Design Manual"

TABLE 4

FULL FLOW COEFFICIENT VALUES
ELLIPTICAL CONCRETE PIPE

Pipe Size R x S (HE) S x R (VE) (Inches)	Approximate Equivalent Circular Diameter (Inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3}$			
				n = 0.010	n = 0.011	n = 0.012	n = 0.013
14 x 23	18	1.8	0.367	138	125	116	108
19 x 30	24	3.3	0.490	301	274	252	232
22 x 34	27	4.1	0.546	405	368	339	313
24 x 38	30	5.1	0.613	547	497	456	421
27 x 42	33	6.3	0.686	728	662	607	560
29 x 45	36	7.4	0.736	891	810	746	686
32 x 49	39	8.8	0.812	1140	1036	948	875
34 x 53	42	10.2	0.875	1386	1260	1156	1067
38 x 60	48	12.9	0.969	1878	1707	1565	1445
43 x 68	54	16.6	1.106	2635	2395	2196	2027
48 x 76	60	20.5	1.229	3491	3174	2910	2686
53 x 83	66	24.8	1.352	4503	4094	3753	3464
58 x 91	72	29.5	1.475	5680	5164	4734	4370
63 x 98	78	34.6	1.598	7027	6388	5856	5406
68 x 106	84	40.1	1.721	8560	7790	7140	6590
72 x 113	90	46.1	1.845	10300	9365	8584	7925
77 x 121	96	52.4	1.967	12220	11110	10190	9403
82 x 128	102	59.2	2.091	14380	13070	11980	11060
87 x 136	108	66.4	2.215	16770	15240	13970	12900
92 x 143	114	74.0	2.340	19380	17620	16150	14910
97 x 151	120	82.0	2.461	22190	20180	18490	17070
106 x 166	132	99.2	2.707	28630	26020	23860	22020
116 x 180	144	118.6	2.968	36400	33100	30340	28000

TABLE 5

FULL FLOW COEFFICIENT VALUES
CONCRETE ARCH PIPE

Pipe Size R x S (Inches)	Approximate Equivalent Circular Diameter (Inches)	A Area (Square Feet)	R Hydraulic Radius (Feet)	Value of $C_1 = \frac{1.486}{n} \times A \times R^{2/3}$			
				n 0.010	n - 0.011	n 0.012	n 0.013
11 x 18	15	1.1	0.25	65	59	54	50
13½ x 22	18	1.6	0.30	110	100	91	84
15½ x 26	21	2.2	0.36	165	150	137	127
18 x 28½	24	2.8	0.45	243	221	203	187
22½ x 36¼	30	4.4	0.56	441	401	368	339
26⅝ x 43¾	36	6.4	0.68	736	669	613	566
31⁵⁄₁₆ x 51⅛	42	8.8	0.80	1125	1023	938	866
36 x 58½	48	11.4	0.90	1579	1435	1315	1214
40 x 65	54	14.3	1.01	2140	1945	1783	1646
45 x 73	60	17.7	1.13	2851	2592	2376	2193
54 x 88	72	25.6	1.35	4641	4219	3867	3569
62 x 102	84	34.6	1.57	6941	6310	5784	5339
72 x 115	90	44.5	1.77	9668	8789	8056	7436
77¼ x 122	96	51.7	1.92	11850	10770	9872	9112
87⅛ x 138	108	66.0	2.17	16430	14940	13690	12640
96⅞ x 154	120	81.8	2.42	21975	19977	18312	16904
106½ x 168¾	132	99.1	2.65	28292	25720	23577	21763

FROM:
American Iron and Steel Institute, 1994
"Handbook of Steel Drainage & Highway Construction Products"

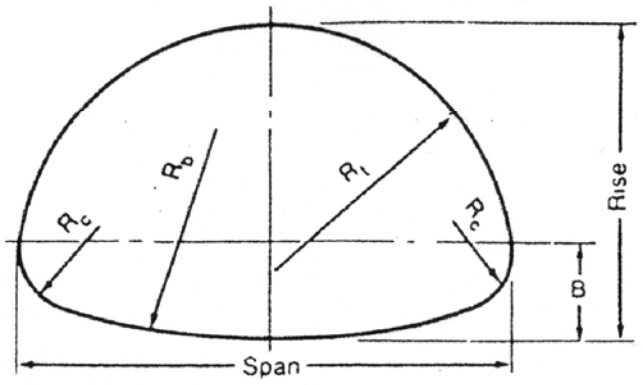


***Table 2.18 Sizes and Layout Details—CSP Pipe Arch. 2 ⅔ x ½ in. Corrugation**

Equiv. Diameter, in.	Span, in.	Rise, in.	Waterway Area, ft²	Layout Dimensions			
				B in.	R_c in.	R_t in.	R_b in.
15	17	13	1.1	4 1/8	3 1/2	8 5/8	25 5/8
18	21	15	1.6	4 7/8	4 1/8	10 3/4	33 1/8
21	24	18	2.2	5 5/8	4 7/8	11 7/8	34 5/8
24	28	20	2.9	6 1/2	5 1/2	14	42 1/4
30	35	24	4.5	8 1/8	6 7/8	17 7/8	55 1/8
36	42	29	6.5	9 3/4	8 1/4	21 1/2	66 1/8
42	49	33	8.9	11 3/8	9 5/8	25 1/8	77 1/4
48	57	38	11.6	13	11	28 5/8	88 1/4
54	64	43	14.7	14 5/8	12 3/8	32 1/4	99 1/4
60	71	47	18.1	16 1/4	13 3/4	35 3/4	110 1/4
66	77	52	21.9	17 7/8	15 1/8	39 3/8	121 1/4
72	83	57	26.0	19 1/2	16 1/2	43	132 1/4

***Table 2.19 Sizes and Layout Details—CSP Pipe-Arch 3 x 1 or 5 x 1 in. Corrugation**

Equiv. Diameter, in.	Nominal Size, in.	Design		Waterway Area, ft²	Layout Dimensions			
		Span, in.	Rise, in.		B in.	R_c in.	R_t in.	R_b in.
48	53 x 41	53	41	11.7	15 1/4	10 3/16	28 1/16	73 7/16
54	60 x 46	58 1/2	48 1/2	15.6	20 1/2	18 3/4	29 3/8	51 1/8
60	66 x 51	65	54	19.3	22 3/4	20 3/4	32 5/8	56 1/4
66	73 x 55	72 1/2	58 1/4	23.2	25 1/8	22 7/8	36 3/4	63 3/4
72	81 x 59	79	62 1/2	27.4	23 3/4	20 7/8	39 1/2	82 5/8
78	87 x 63	86 1/2	67 1/4	32.1	25 3/4	22 5/8	43 3/8	92 1/4
84	95 x 67	93 1/2	71 3/4	37.0	27 3/4	24 3/8	47	100 1/4
90	103 x 71	101 1/2	76	42.4	29 3/4	26 1/8	51 1/4	111 5/8
96	112 x 75	108 1/2	80 1/2	48.0	31 5/8	27 3/4	54 1/8	120 1/4
102	117 x 79	116 1/2	84 3/4	54.2	33 5/8	29 1/2	59 3/8	131 3/4
108	128 x 83	123 1/2	89 1/4	60.5	35 5/8	31 1/4	63 1/4	139 3/4
114	137 x 87	131	93 3/4	67.4	37 5/8	33	67 3/8	149 1/2
120	142 x 91	138 1/2	98	74.5	39 1/2	34 3/4	71 5/8	162 3/8
126	150 x 96	146	102	81	41	36	76	172
132	157 x 101	153	107	89	43	38	80	180
138	164 x 105	159	113	98	45	40	82	184
144	171 x 110	165	118 1/2	107	47	41	85	190

*Dimensions shown not for specification purposes, subject to manufacturing tolerances.

FROM:

American Society of Civil Engineers
ASCE Manuals and Reports of Engineering Practice No. 77
"Design and Construction of Urban Stormwater Management Systems"

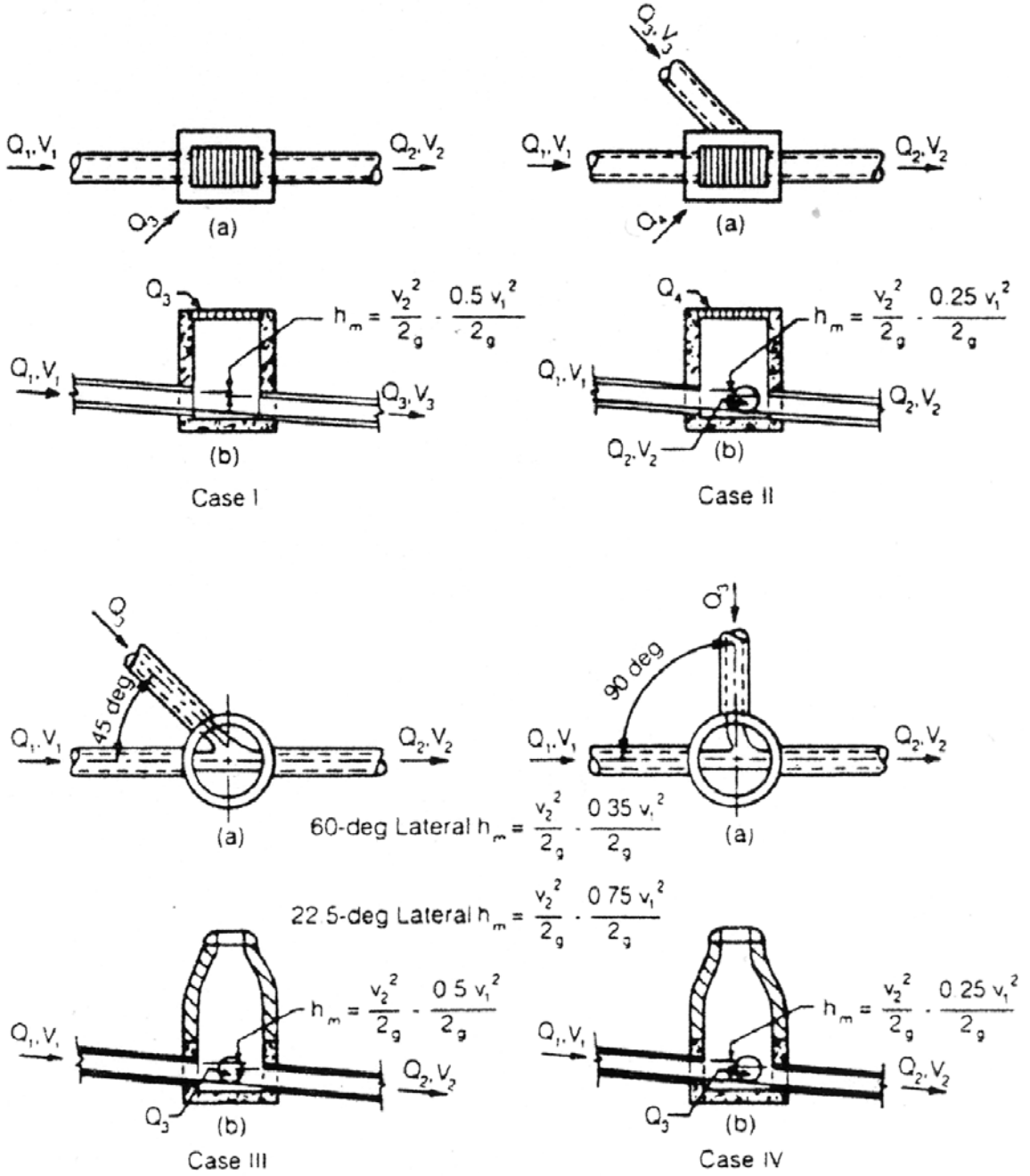
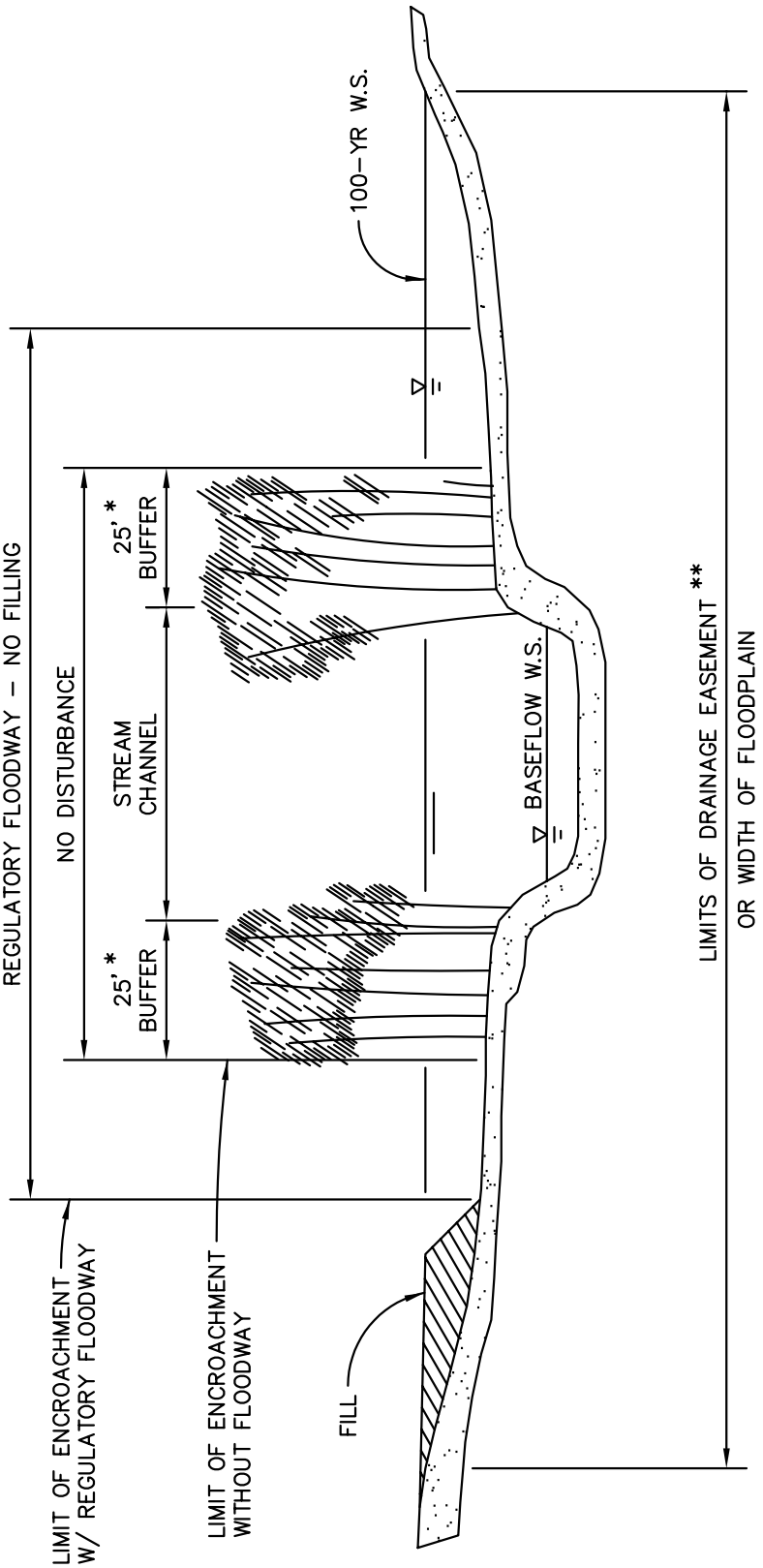


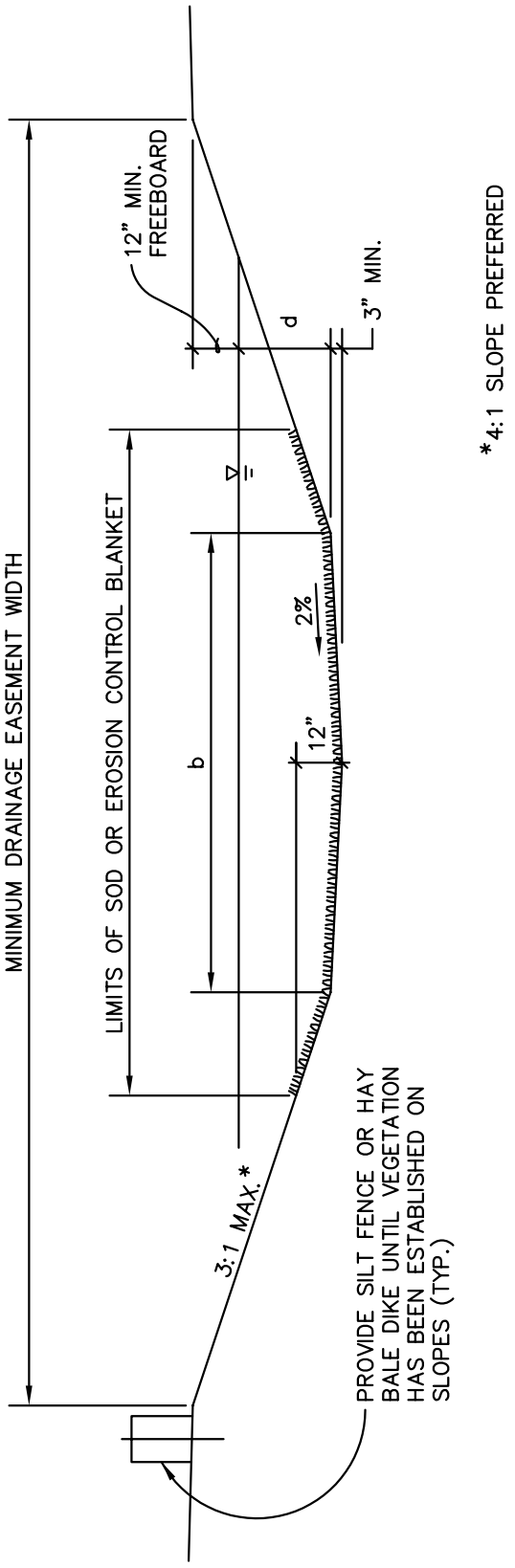
Figure 6.14—Minor head losses due to turbulence at structures: case I—inlet on main line (a) plan and (b) section, case II—inlet on main line with branch lateral (a) plan and (b) section, case III—manhole on main line with 45-deg branch lateral (a) plan and (b) section, and case IV—manhole on main line with 90-deg branch lateral (a) plan and (b) section (City of Austin, 1987).



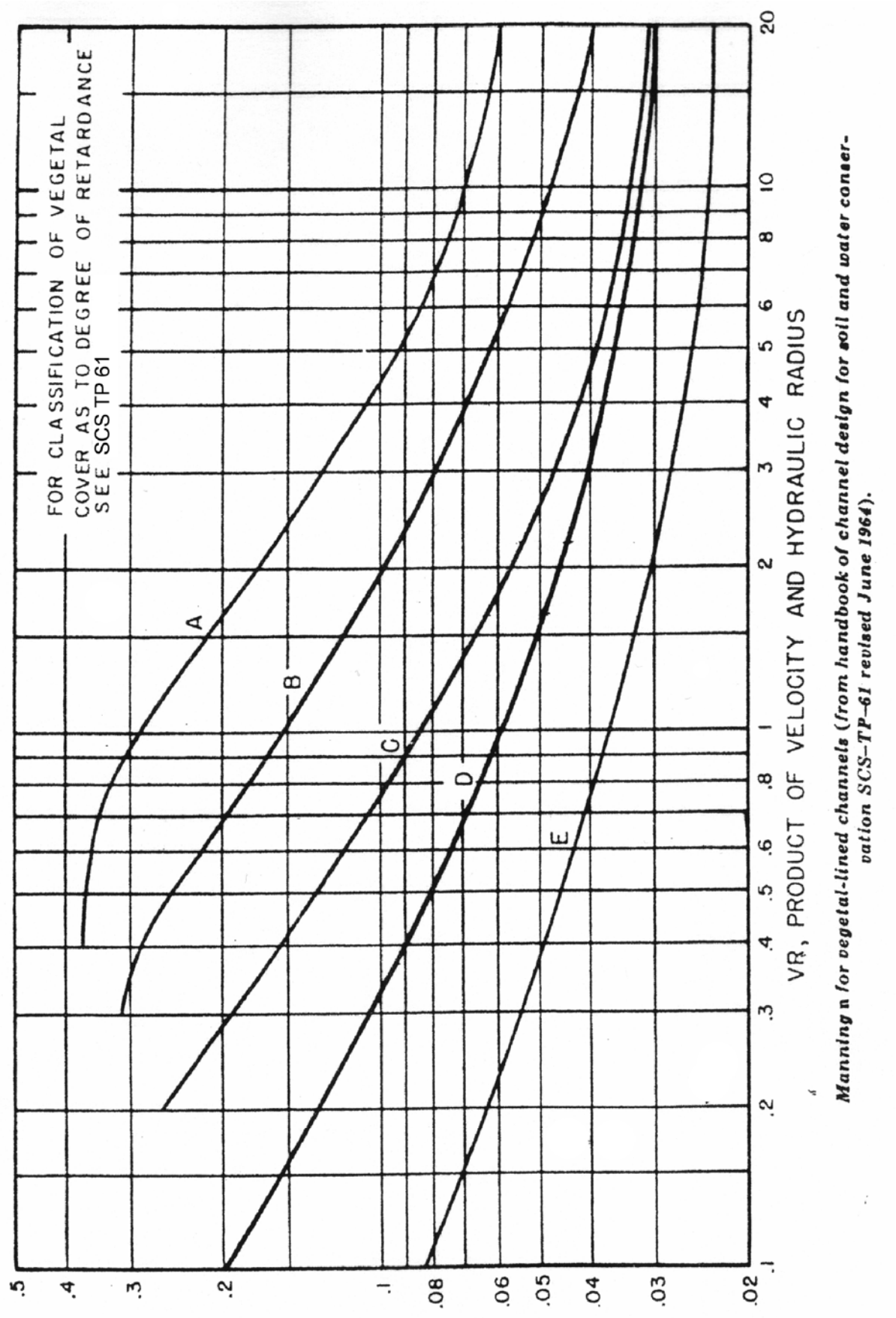
* EXISTING VEGETATION TO REMAIN. 100' WIDTH PREFERRED.

** USE FULLY URBANIZED CONDITIONS FOR PEAK FLOW RATE.

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	TYPICAL NATURAL CHANNEL	ADOPTED: 10/15/02 SS-G1

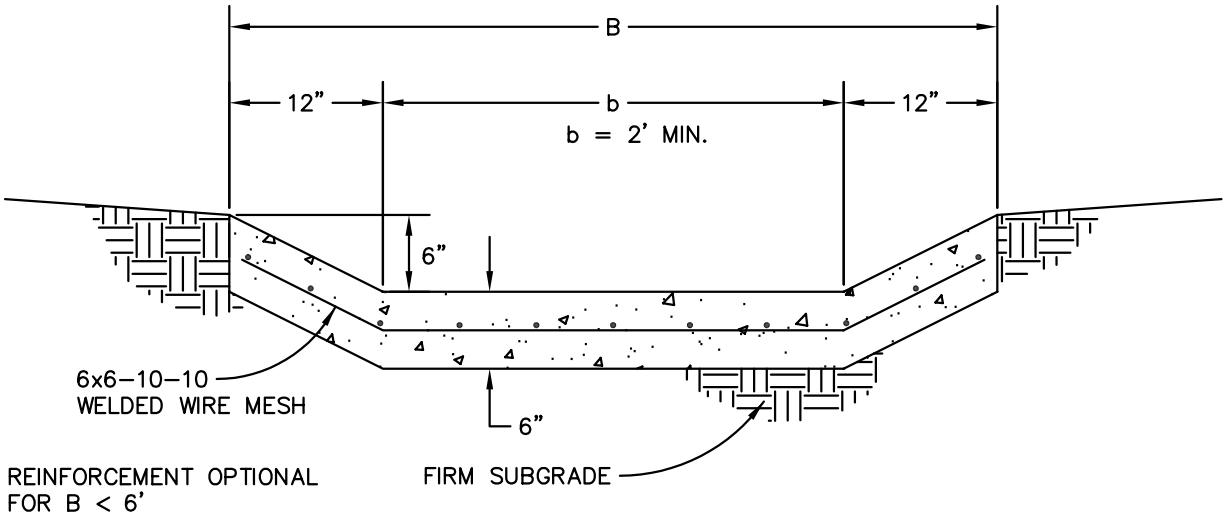


CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TYPICAL GRASS–LINED CHANNEL	ADOPTED: 10/15/02 SS–G2



Manning n for vegetal-lined channels (from handbook of channel design for soil and water conservation SCS–TP–61 revised June 1964).

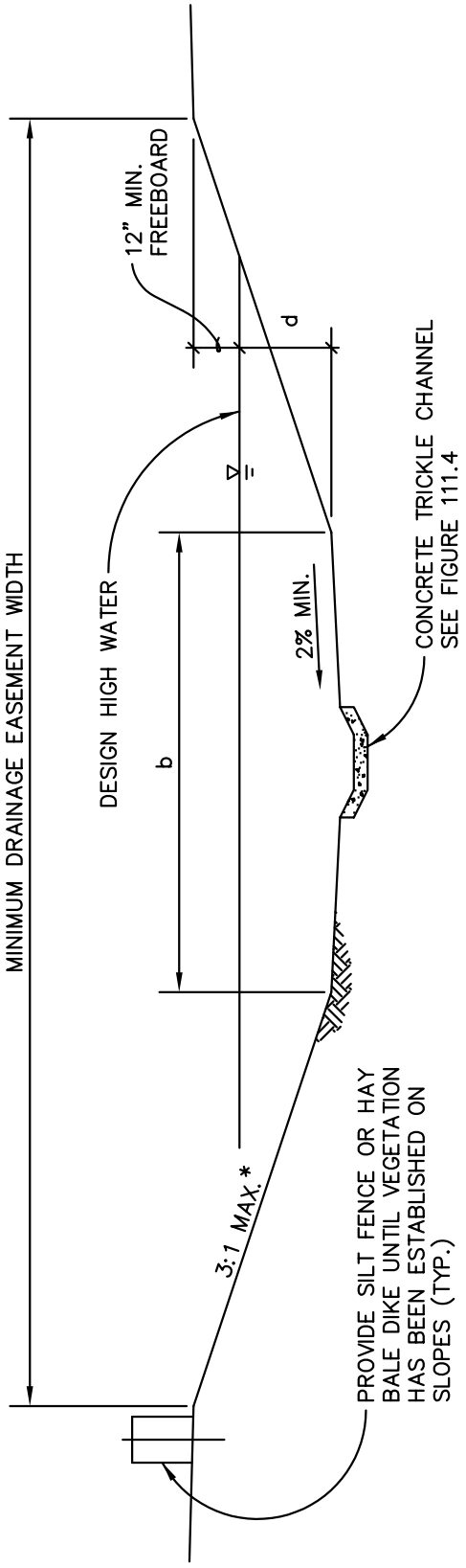
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MANNING'S n FOR GRASS–LINED CHANNELS	ADOPTED: 10/15/02 SS–G3



NOTE: CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF CHAPTER VII OF THE CITY OF SPRINGFIELD TECHNICAL SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION.

DESIGN FLOW RATE (cfs)	RECOMMENDED TRICKLE CHANNEL WIDTH, b (ft)
< 150	2'
150 – 200	3'
200 – 250	4'
250 – 350	5'
> 350	DETERMINE ON CASE BY CASE BASIS

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CONCRETE TRICKLE CHANNEL	ADOPTED: 10/15/02 SS–G4



*4:1 SLOPE PREFERRED

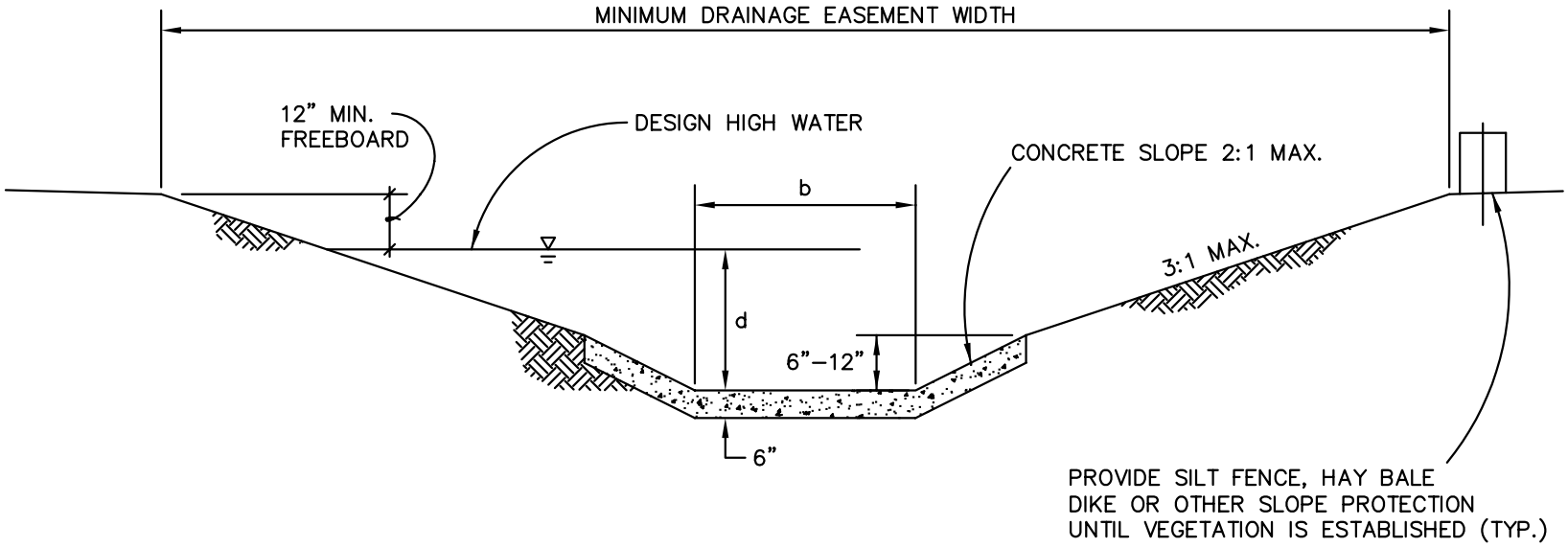
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	GRASS–LINED CHANNEL W/ CONC TRICKLE	ADOPTED: 10/15/02 SS–G5

CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

CHANNEL W CONC INVERT & GRASS SIDE SLOPES

ADOPTED: 10/15/02

SS-G6



NOTES:

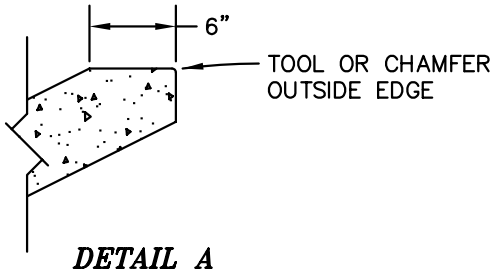
1. CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF CHAPTER VII OF THE CITY OF SPRINGFIELD TECHNICAL SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION.
2. PROVIDE 6x6–10–10 WELDED WIRE MESH OR EQUIVALENT REINFORCEMENT FOR b > 4 FEET.

CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

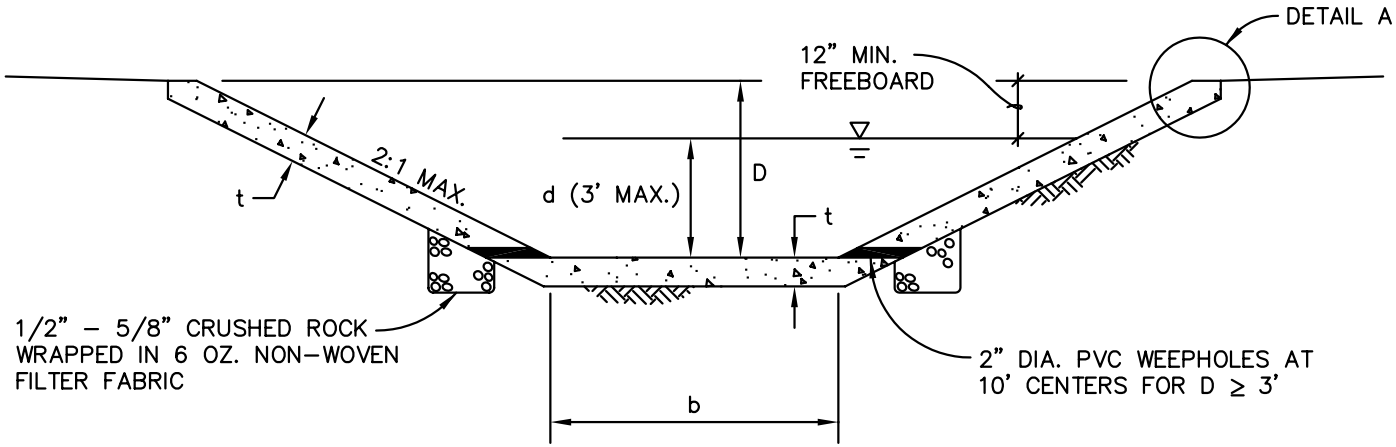
TRAPEZOIDAL CONCRETE CHANNEL

ADOPTED: 10/15/02

SS-G7



DETAIL A



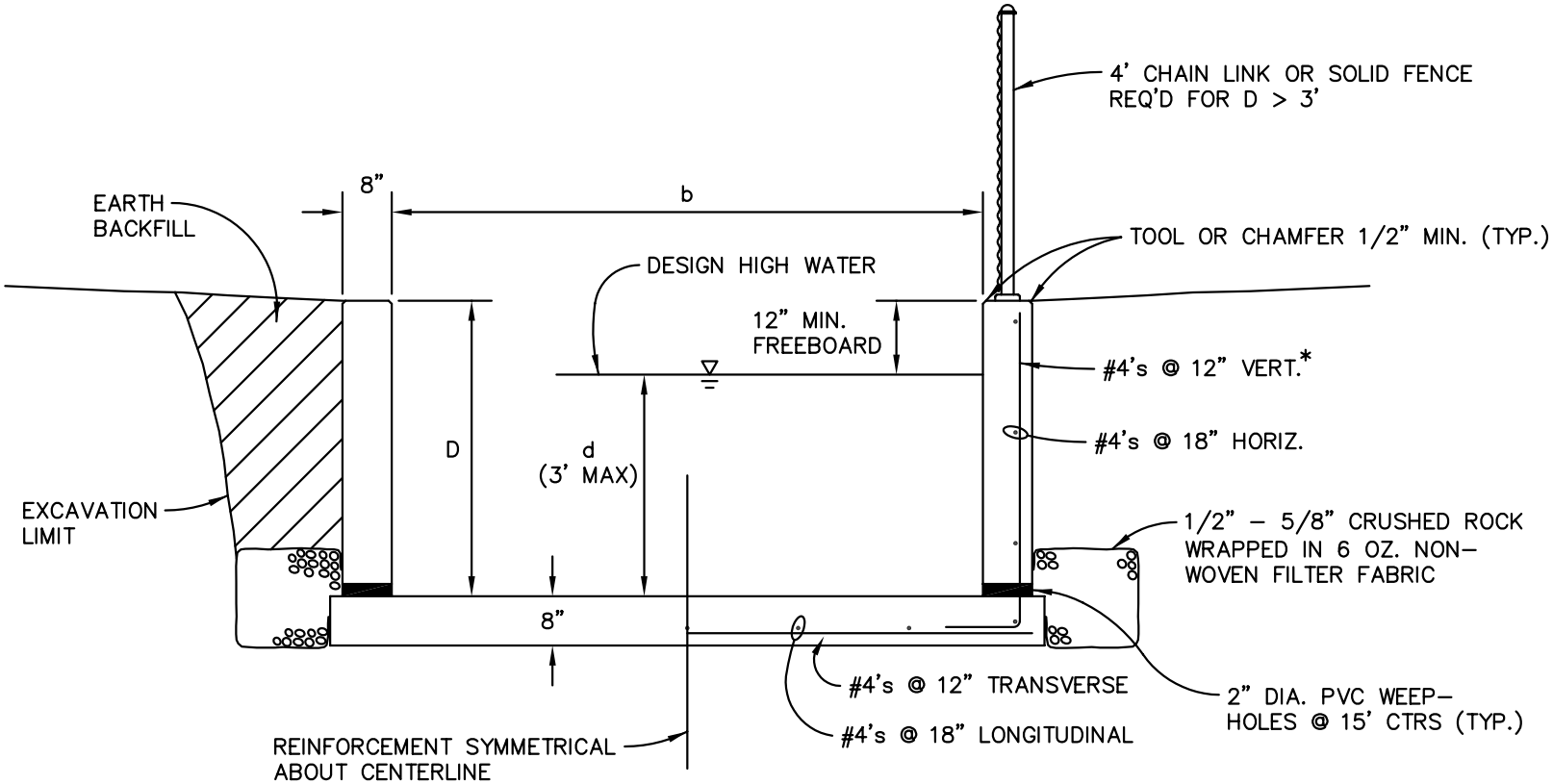
NOTES:

1. B ≤ 5', t = 6" REINFORCE WITH 6x6–10–10 WWM
   B > 5', t = 8" REINFORCE WITH #4's @ 12" TRANSVERSE, #4's @ 18" LONGITUDINAL

2. CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF CHAPTER VII OF THE CITY OF SPRINGFIELD TECHNICAL SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION.

CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

RECTANGULAR CONCRETE CHANNEL

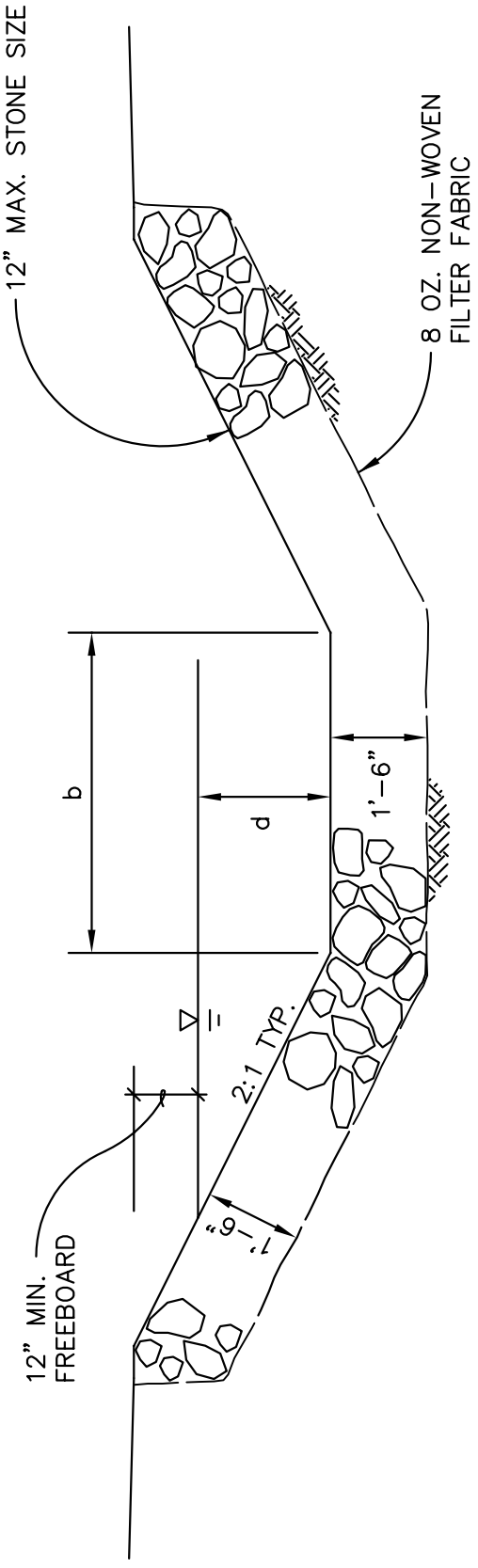


NOTE: CONCRETE SHALL CONFORM TO THE REQUIREMENTS OF CHAPTER VII OF THE CITY OF SPRINGFIELD TECHNICAL SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION.

*FOR D ≤ 5'. DESIGNER MUST SPECIFY WHEN D > 5'.

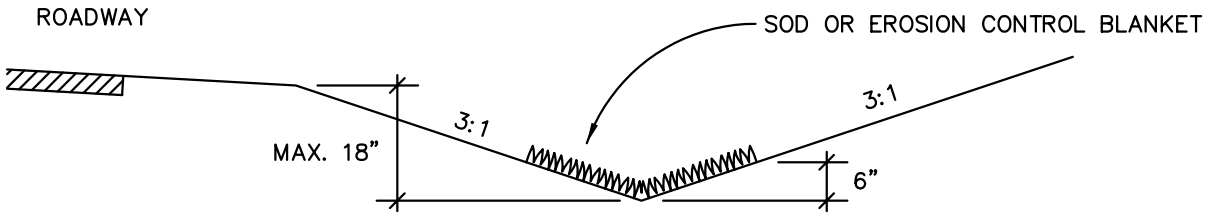
ADOPTED: 10/15/02

SS-G8

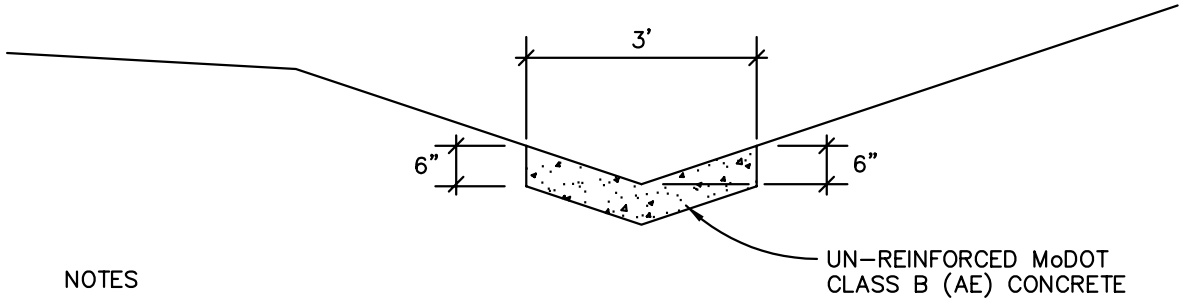


NOTE: RIPRAP SHALL BE GROUTED

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	TYPICAL RIPRAP LINED CHANNEL	ADOPTED: 10/15/02 SS-G9



GRASS LINING

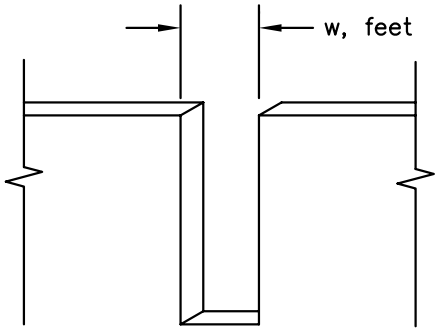


NOTES

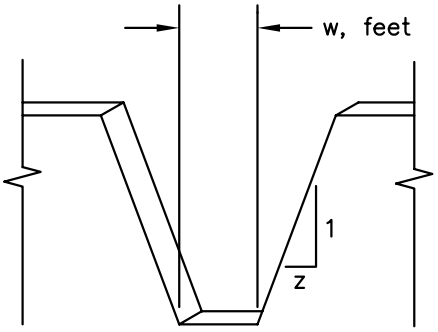
1. PROVIDE TOOLED OR SAWCUT CONTRACTION JOINTS AT MAXIMUM 10' SPACING.
2. PROVIDE EXPANSION JOINT WITH 1/2" EXPANSION MATERIAL AT MAXIMUM 50' SPACING.

CONCRETE LINING

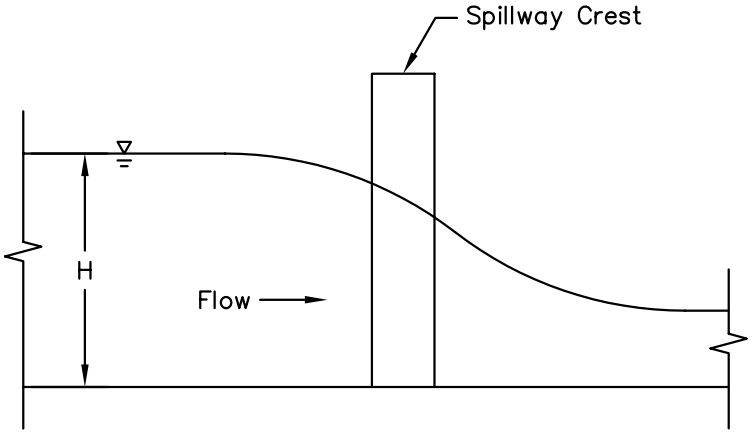
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	ROADSIDE DITCHES	ADOPTED: 10/15/02 SS–G10



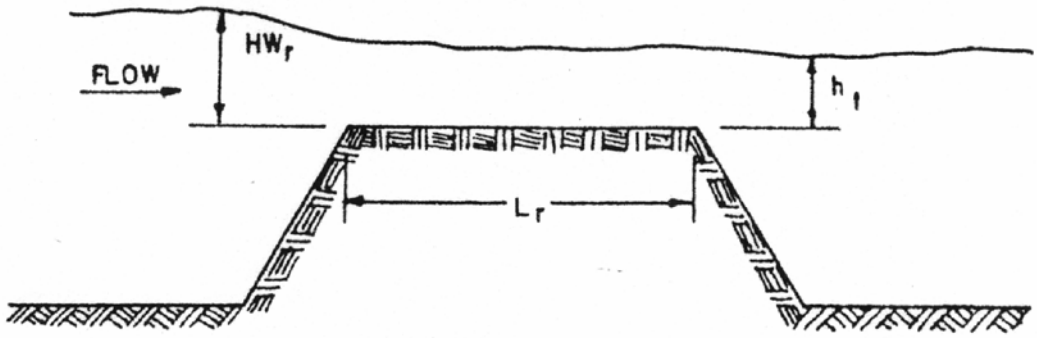
VERTICAL SLOT OUTLET

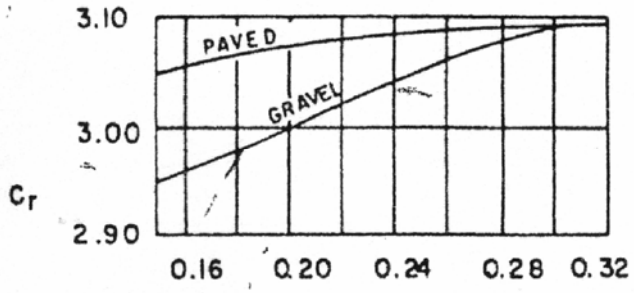


SLOPING SLOT OUTLET



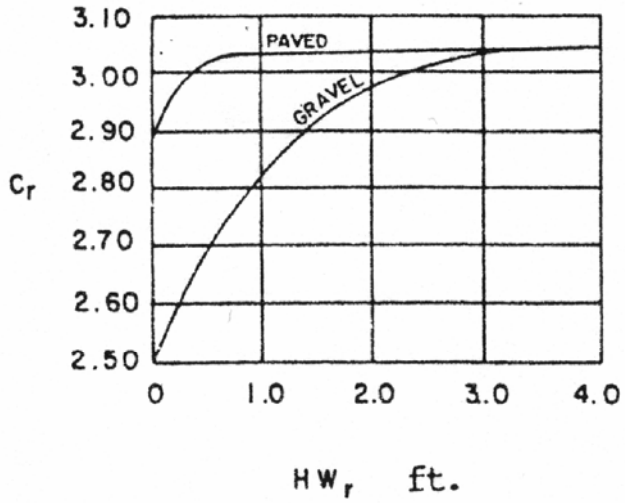
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	SLOT OUTLET DEFINITION SKETCH	ADOPTED: 10/15/02 SS–H1



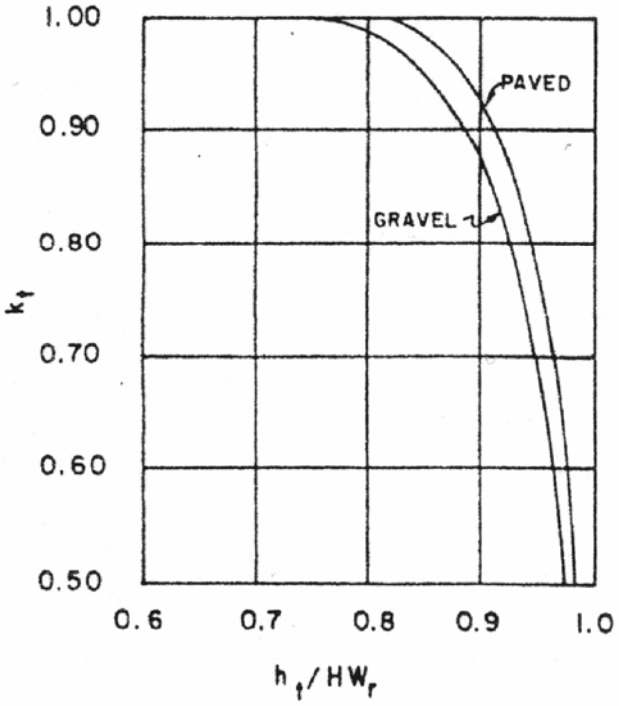


A) DISCHARGE COEFFICIENT FOR $HW_r / L_r > 0.15$

$C_d = k_t C_r$



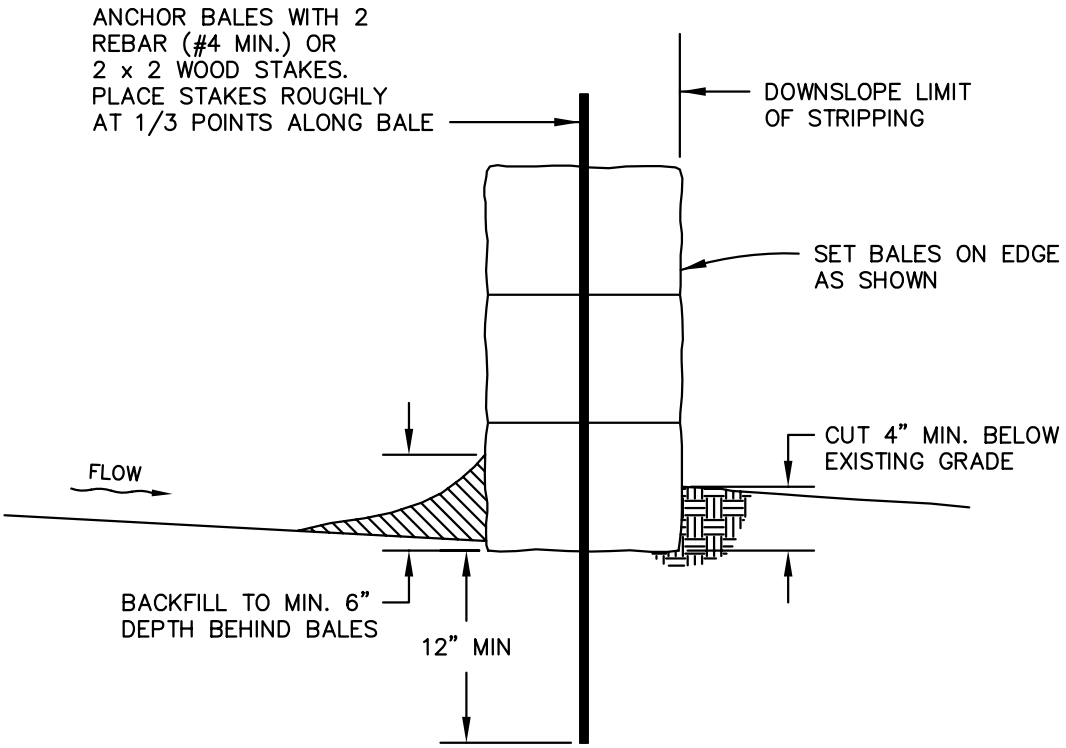
B) DISCHARGE COEFFICIENT FOR $HW_r / L_r \leq 0.15$



C) SUBMERGENCE FACTOR

From "Hydraulic Design of Highway Culverts," HDS-5, Federal Highway Administration, 1985.

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	DISCHARGE COEFF. FOR FLOW OVER WIDE EMB	ADOPTED: 10/15/02 SS–H2

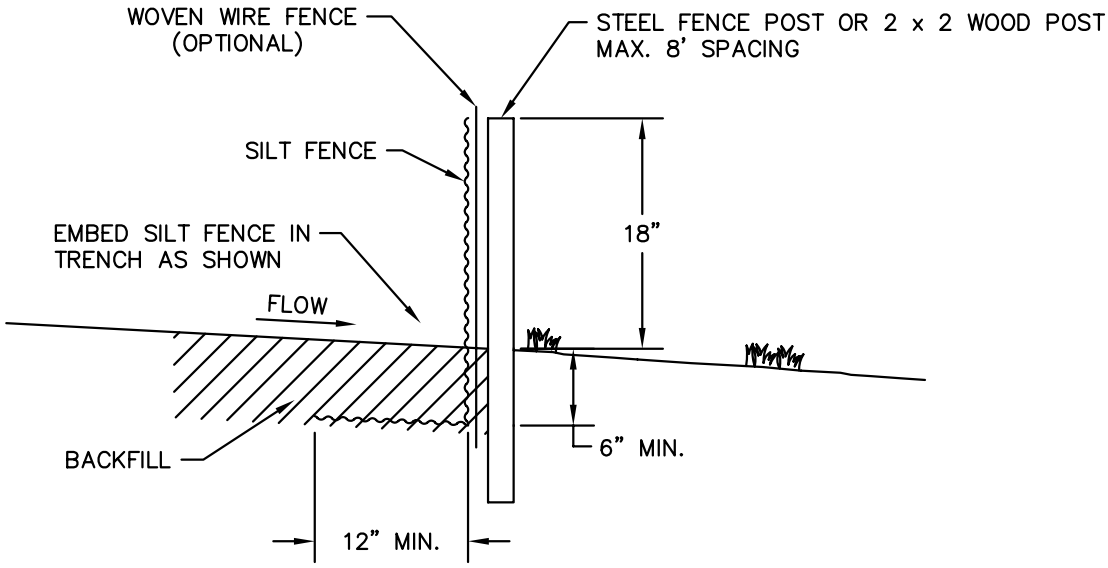


NOTES:

1. PLACE HAY BALE DIKE AT DOWNSLOPE LIMIT OF AREA TO BE GRADED.
2. BALES SHALL BE PLACED IN A ROW WITH ENDS TIGHTLY ABUTTING THE ADJACENT BALES.
3. BALES SHALL BE PLACED ALONG A LEVEL CONTOUR WITH AN ALLOWANCE OF ±4 INCHES.
4. SEDIMENT TRAPPED SHALL BE DISPOSED IN AN APPROVED LOCATION IN A MANNER WHICH WILL NOT CONTRIBUTE ADDITIONAL SILTATION.
5. EACH BALE SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF FOUR INCHES.
6. BALES SHALL BE SECURELY ANCHORED IN PLACE BY STAKES OR RE-BARS DRIVEN THROUGH THE BALES. THE FIRST STAKE IN EACH BALE SHALL BE ANGLED TOWARD PREVIOUSLY LAID BALE TO FORCE BALES TOGETHER.
7. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED BY CONTRACTOR.
8. BALES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
9. ACCUMULATED SILT SHALL BE REMOVED WHEN IT REACHES A DEPTH OF 6 INCHES.
10. AT EACH END OF DIKE, TURN DIKE UPSLOPE AND EXTEND UNTIL GROUND SURFACE RISES 18 INCHES.

REFERENCE: Adapted from City of Austin & City of Tulsa Erosion and Sedimentation Control Manuals

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	HAY BALE DIKE	ADOPTED: 10/15/02 SS–I1

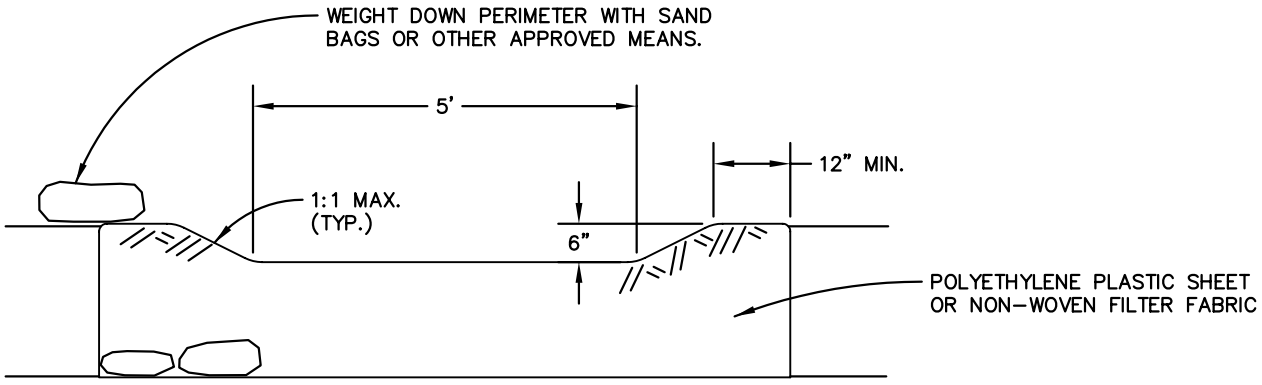


NOTES:

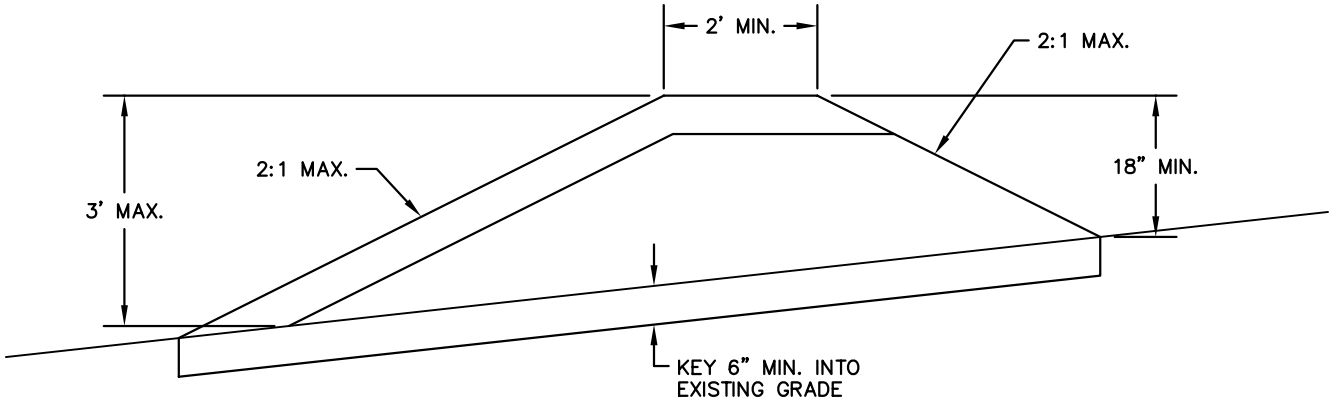
1. PLACE SILT FENCE AT DOWNSLOPE LIMIT OF AREA TO BE GRADED.
2. SILT FENCE SHALL BE PLACED ALONG A LEVEL CONTOUR WITH AN ALLOWANCE OF ± 4 INCHES.
3. SEDIMENT TRAPPED BY THIS PRACTICE SHALL BE DISPOSED OF IN AN APPROVED SITE IN A MANNER THAT WILL NOT CONTRIBUTE TO ADDITIONAL SILTATION.
4. SILT FENCE SHOULD BE SECURELY FASTENED TO EACH SUPPORT POST OR TO WOVEN WIRE, WHICH IS IN TURN ATTACHED TO THE STEEL FENCE POSTS.
5. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
6. SILT FENCE SHALL BE REMOVED WHEN IT HAS SERVED ITS USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
7. ACCUMULATED SILT SHALL BE REMOVED WHEN IT REACHES A DEPTH OF 6 INCHES.
8. AT EACH END OF SILT FENCE, TURN FENCE UPSLOPE AND EXTEND UNTIL GROUND SURFACE RISES 18 INCHES.

REFERENCE: Adapted from City of Austin & City of Tulsa Erosion and Sedimentation Control Manuals

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	SILT FENCE	ADOPTED: 10/15/02 SS–I2



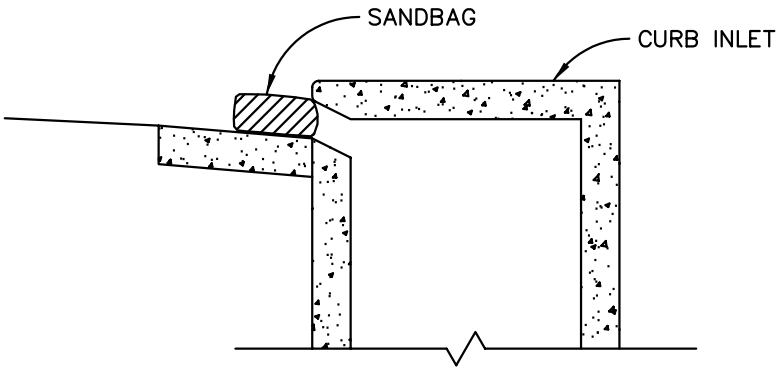
OVERFLOW AREA



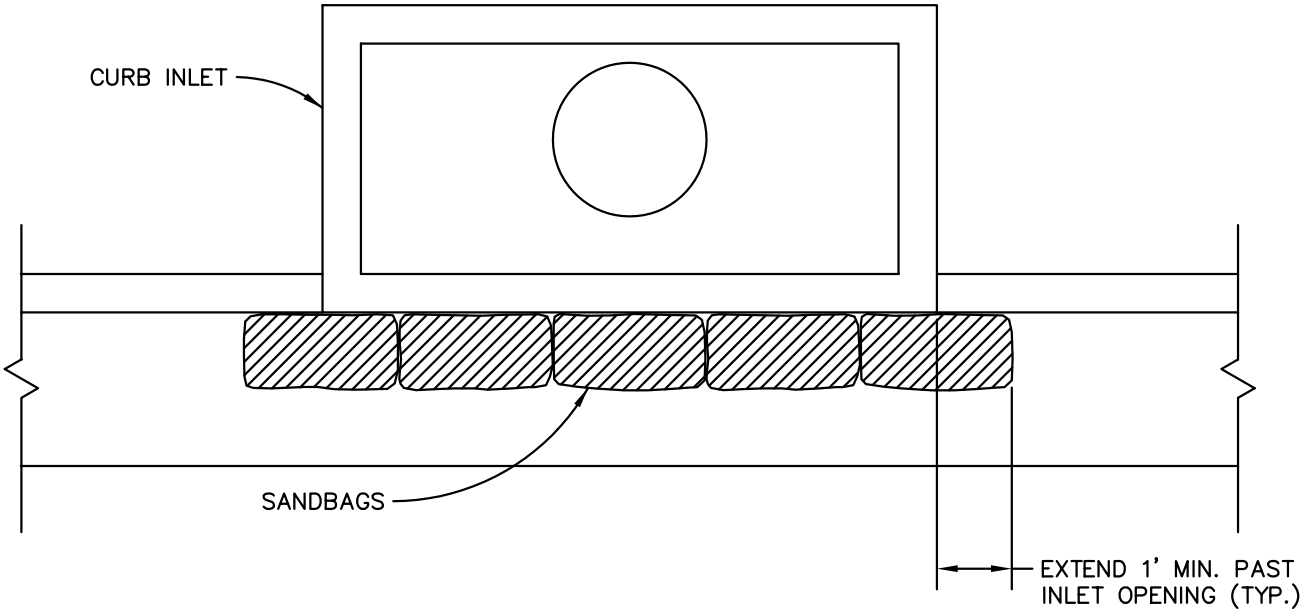
NOTES:

1. SOIL IN BERM SHALL BE FIRMLY COMPACTED.
2. AT EACH END OF BERM, TURN BERM UPSLOPE AND EXTEND UNTIL GROUND SURFACE RISES TO TOP OF BERM ELEVATION.
3. PROVIDE OVERFLOW AREAS AT 200 FT. MAX. INTERVALS.

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TEMPORARY SILT CONTAINMENT BERM	ADOPTED: 10/15/02 SS-13



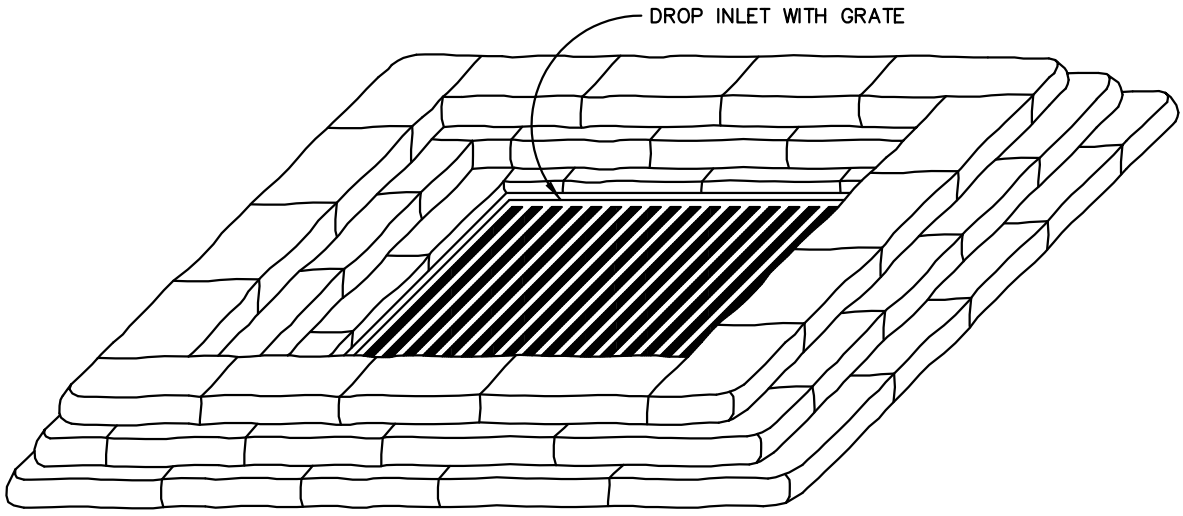
CROSS–SECTION

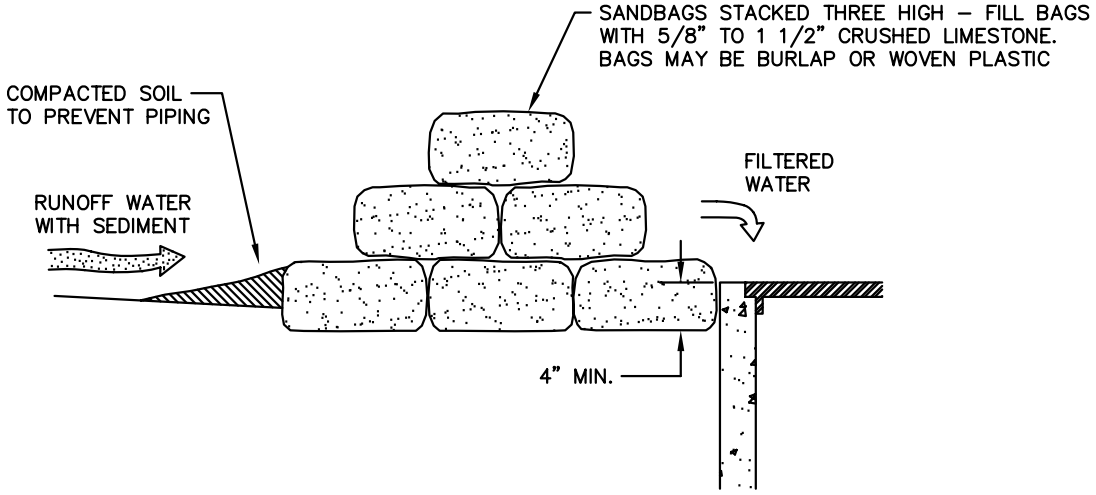


PLAN

NOTES:
1. FILL BAGS WITH 5/8" CRUSHED LIMESTONE.
2. BAGS SHALL BE BURLAP OR BIODEGRADABLE PLASTIC.
3. BAGS SHALL BE INSPECTED AND REPLACED AS NEEDED.

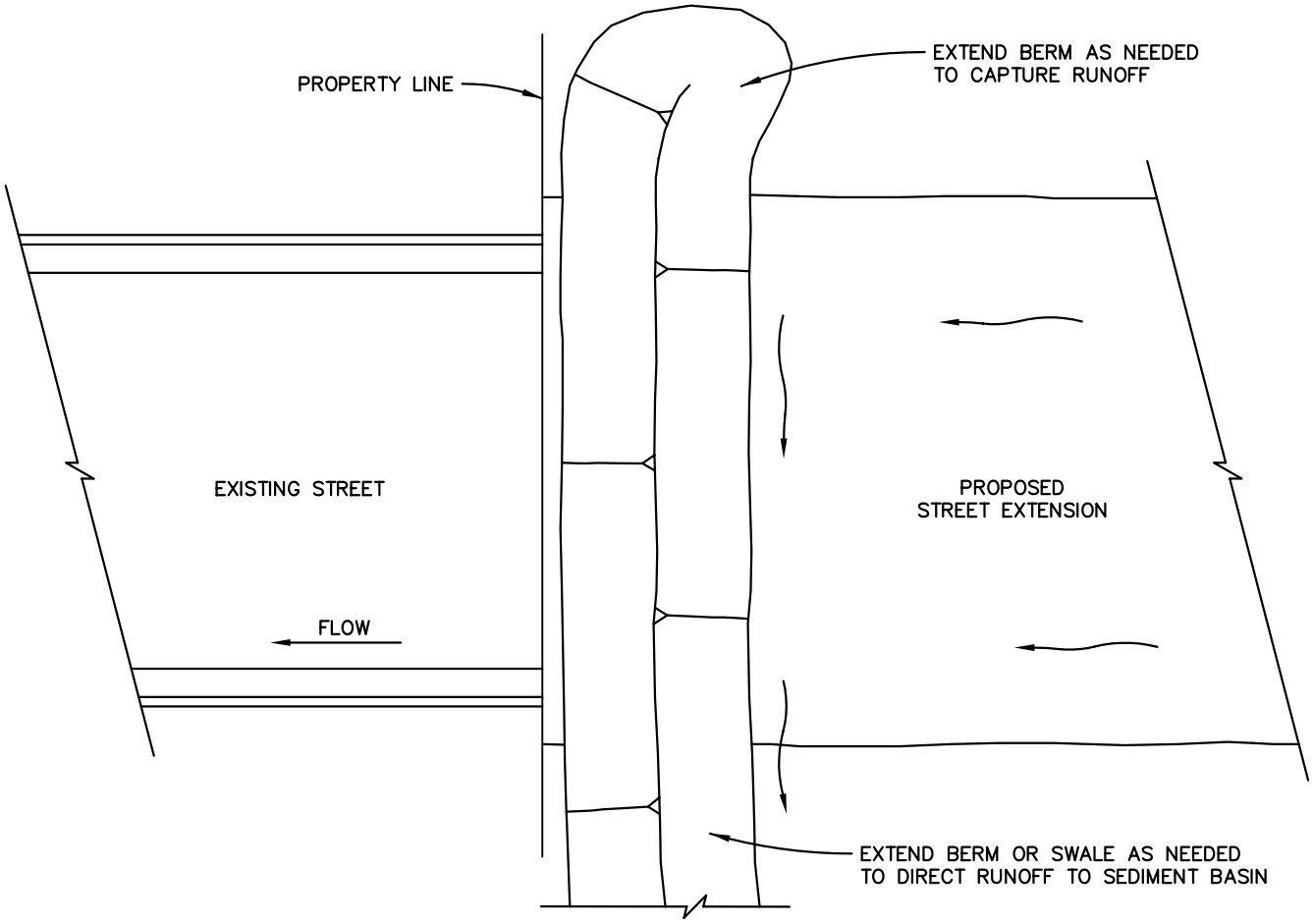
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	SAND BAG SEDIMENT TRAP FOR CURB INLETS	ADOPTED: 10/15/02 SS–14a



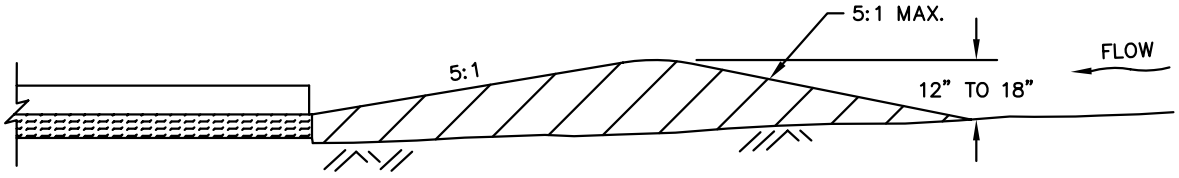


DROP INLET SEDIMENT FILTER

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	AREA INLET PROTECTION	ADOPTED: 10/15/02 SS–14b



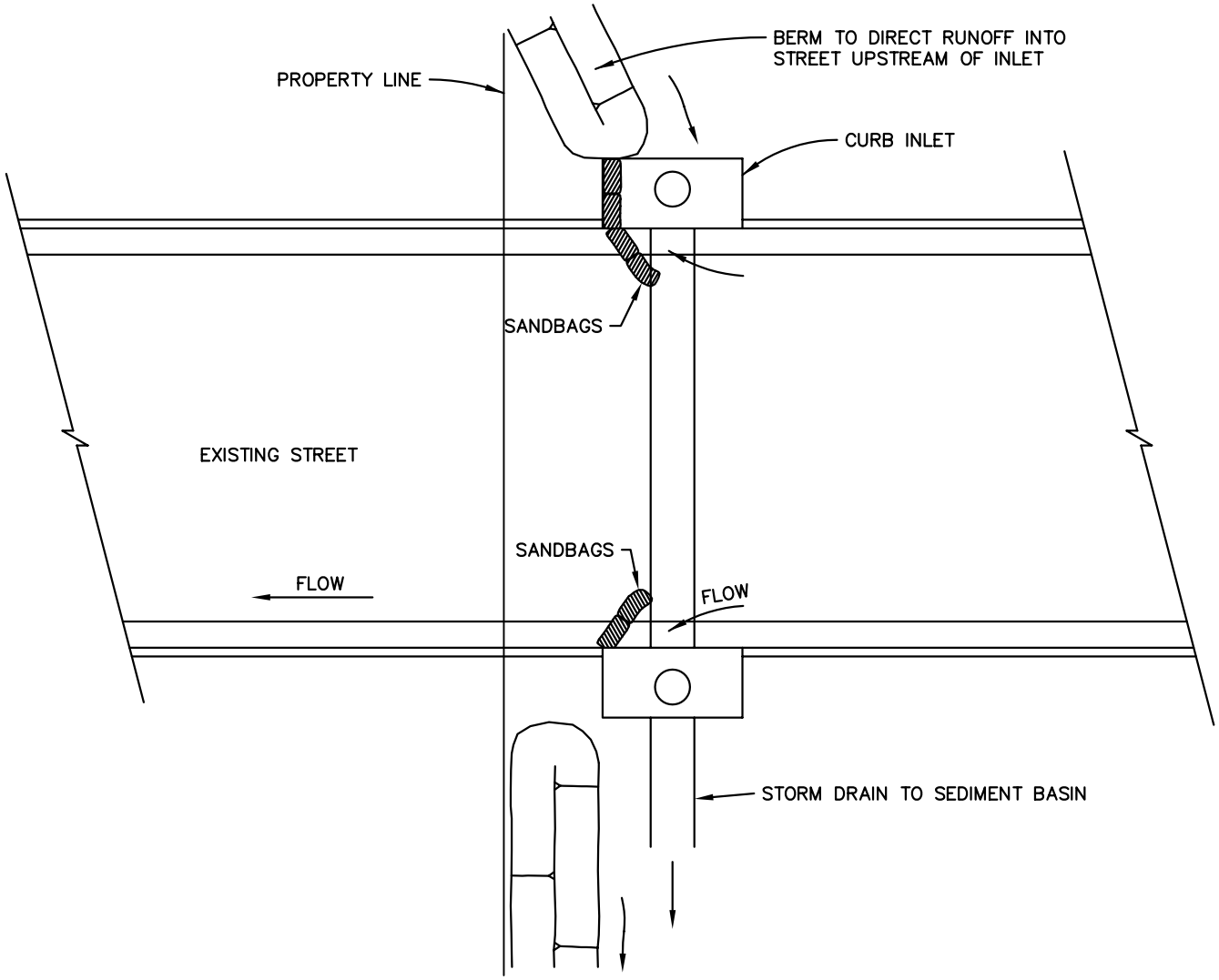
PLAN



CROSS–SECTION

CASE 1 – AFTER INITIAL EXCAVATION OF SUBGRADE

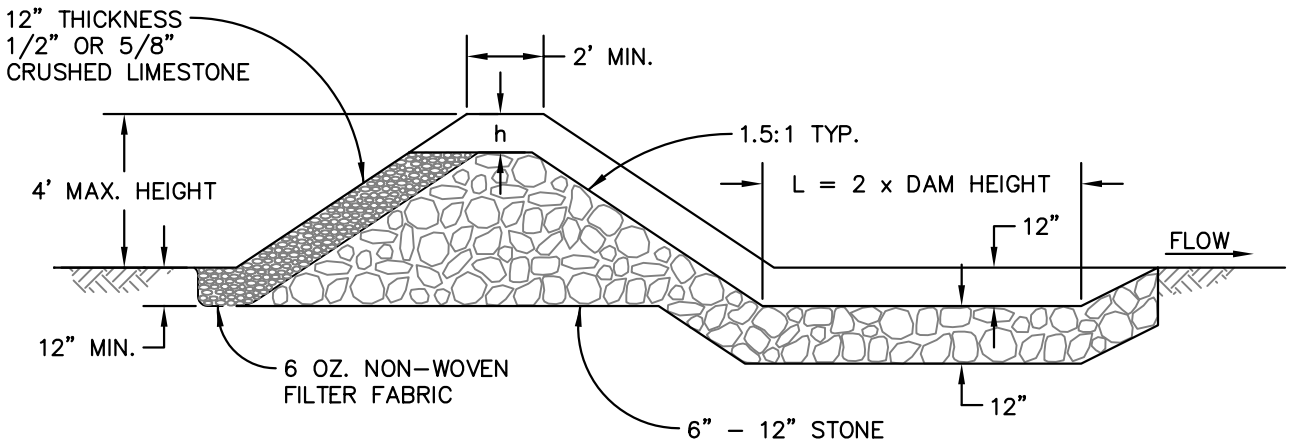
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	DIVERSION OF RUNOFF FOR CURBED STREET	ADOPTED: 10/15/02 SS–I5



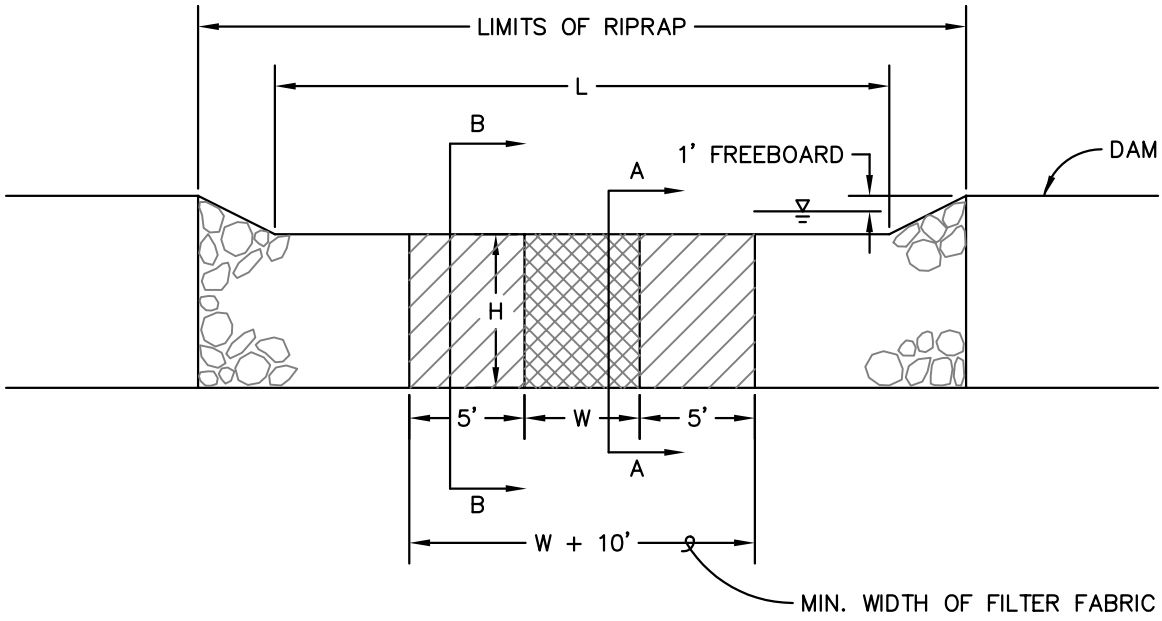
NOTE: FILL SANDBAGS WITH CHAT OR LIMESTONE SAND

CASE 2 – AFTER PAVEMENT AND INLETS COMPLETED

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	DIVERSION OF RUNOFF FOR CURBED STREET	ADOPTED: 10/15/02 SS–16



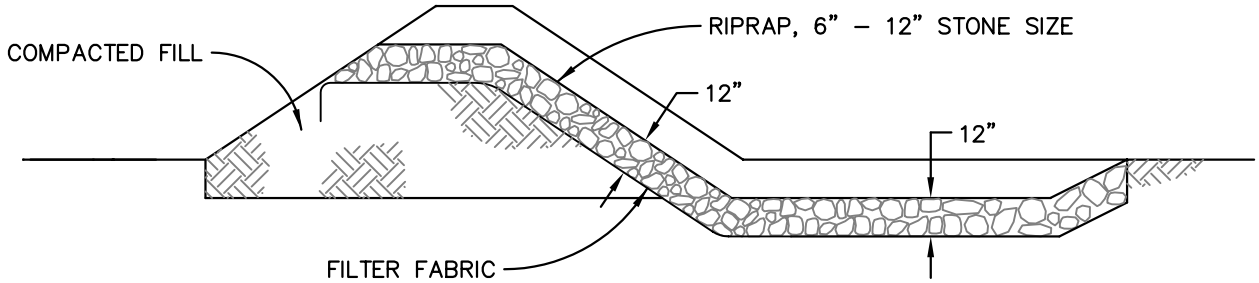
SECTION A - A (THRU GRAVEL FILTER)



L = LENGTH REQUIRED TO PASS Q_{10} WHILE MAINTAINING 1 FT. OF FREEBOARD

W = WIDTH OF ROCK FILTER AREA

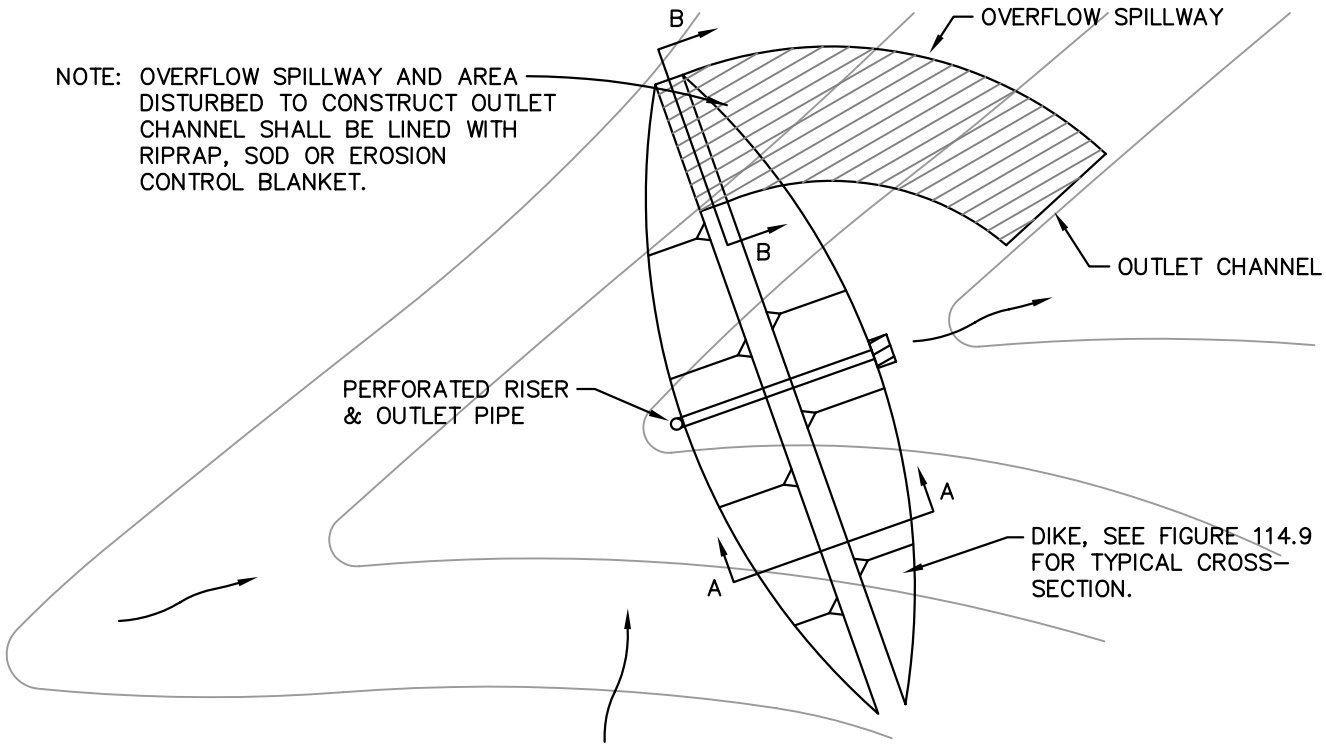
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	GRAVEL FILTER DAM	ADOPTED: 10/15/02 SS-17a



SECTION B – B

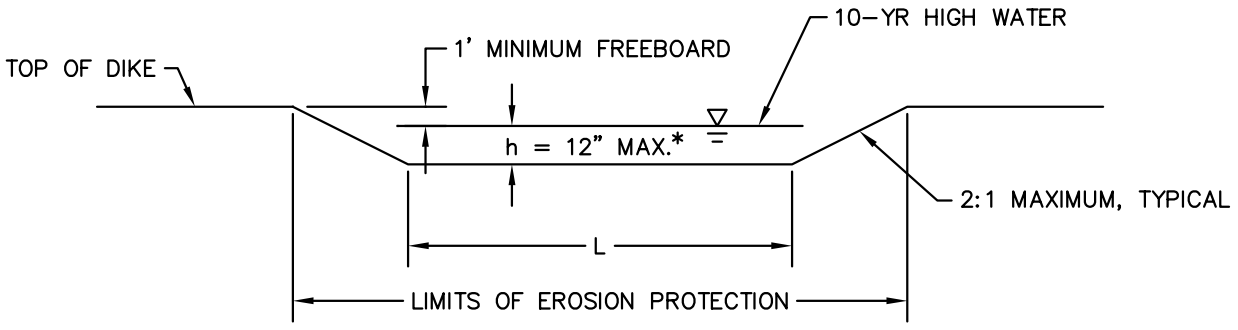
(FIGURE 1.7a)

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	RIPRAP OVERFLOW SPILLWAY	ADOPTED: 10/15/02 SS–17b



TYPICAL COMPONENTS OF TEMPORARY SEDIMENT BASIN PLAN

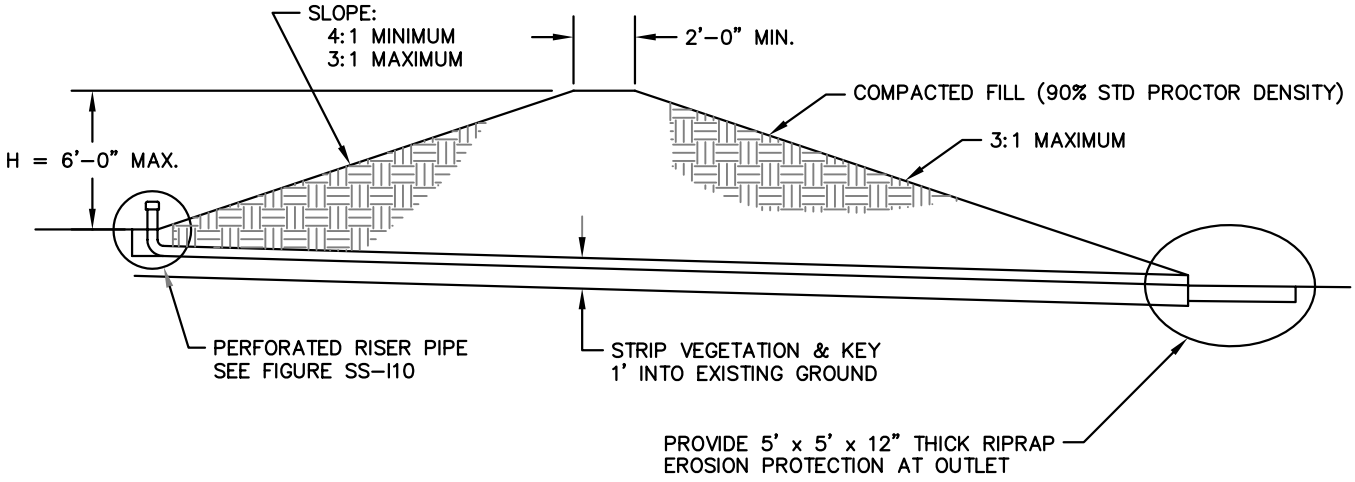
(PERFORATED RISER PIPE AND OVERFLOW SPILLWAY SHOWN. GRAVEL FILTER DAM AND RIPRAP OVERFLOW SPILLWAY AS SHOWN IN FIGURES 114.7A AND 114.7B MAY ALSO BE USED.)



*h = 6" MAX. IF SOD LINING USED

SECTION B -B
TYPICAL OVERFLOW SPILLWAY CROSS-SECTION

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	TEMPORARY SEDIMENT BASIN	ADOPTED: 10/15/02 SS-18



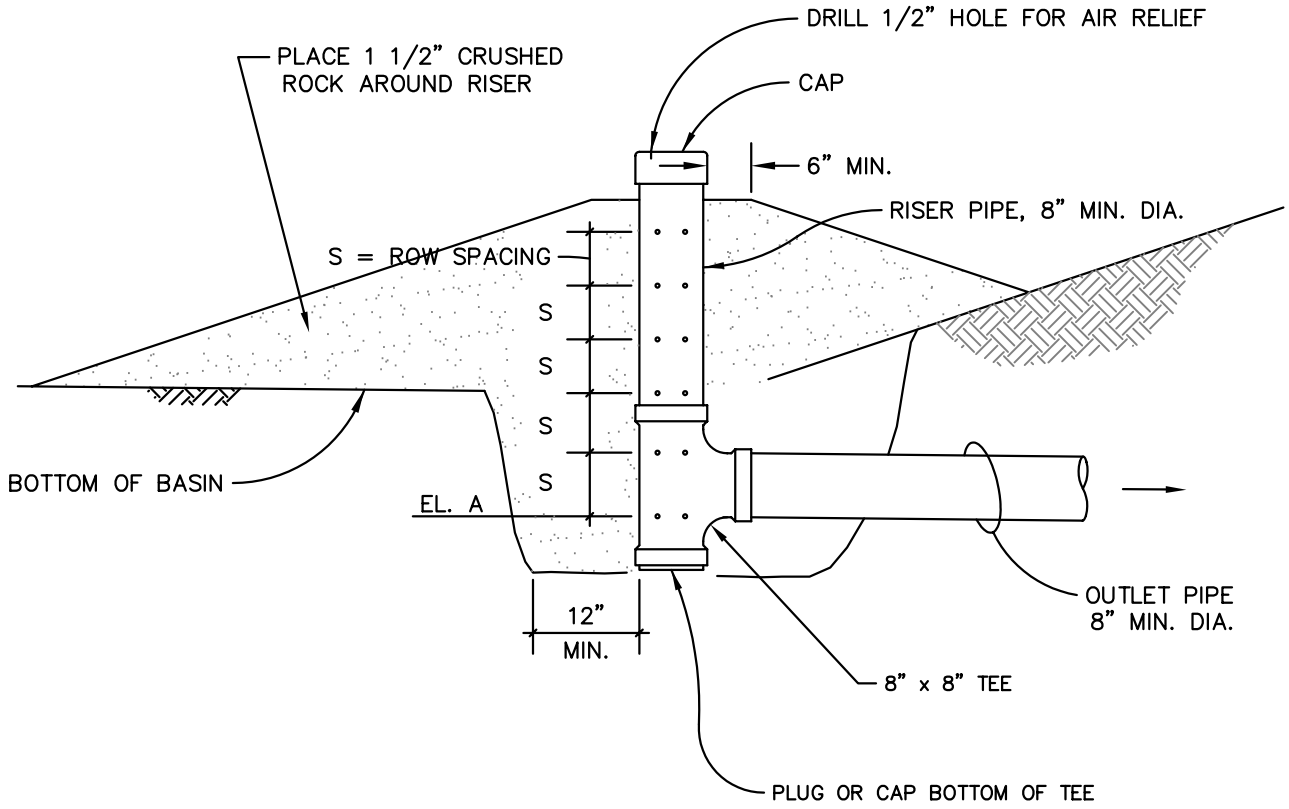
SECTION A – A

(FIGURE SS-18)

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TEMP SEDIMENT BASIN BERM & OUTLET	ADOPTED: 10/15/02 SS-19

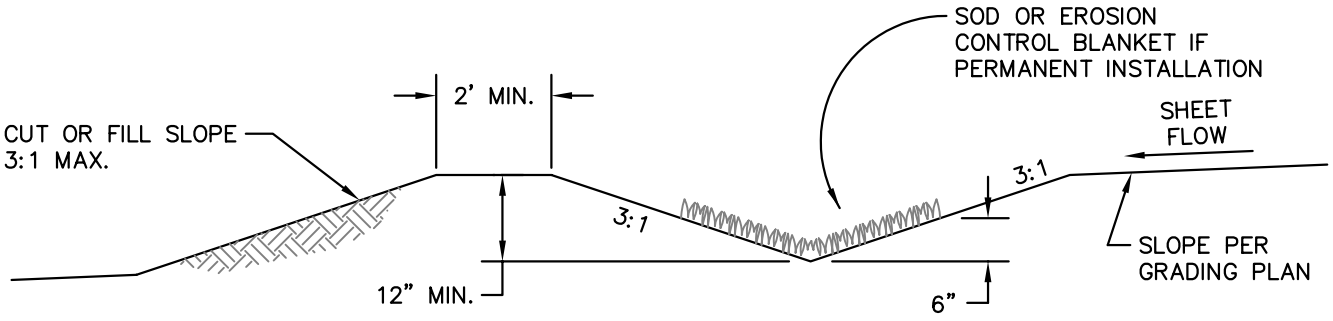
n = NUMBER OF HOLES PER ROW

d = HOLE DIAMETER

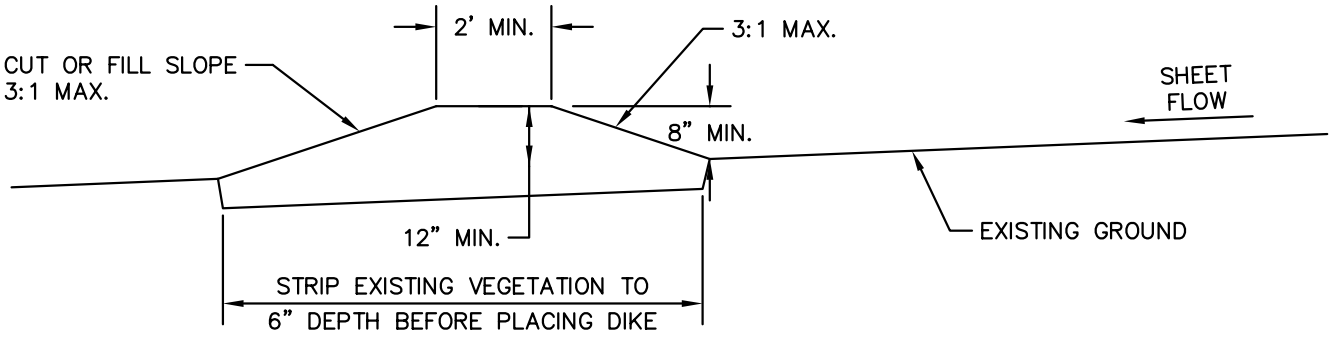


NOTE: BOTTOM ROW OF HOLES SHALL BE SET NO HIGHER THAN BOTTOM OF BASIN. ELEVATION OF BOTTOM ROW OF HOLES SHALL BE SET EQUAL TO INVERT ELEVATION OF OUTLET PIPE (EL. A). THIS ELEVATION MUST BE SPECIFIED ON THE DRAWING.

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TEMP SEDIMENT BASIN PERFORATED RISER PIPE	ADOPTED: 10/15/02 SS–I10



SWALE



DIKE

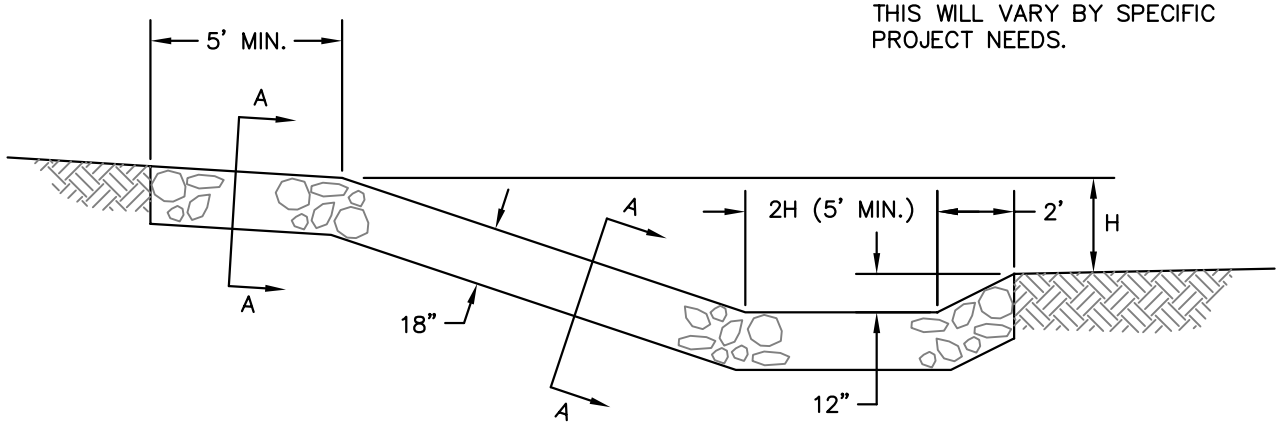
NOTES:

1. DIKE SHALL BE COMPACTED TO DENSITY EQUAL TO THAT SPECIFIED FOR ADJOINING AREA (90% STANDARD PROCTOR DENSITY, MINIMUM).
2. MINIMUM 1% GRADE MUST BE PROVIDED FOR SWALE OR ALONG UPSLOPE SIDE OF DIKE FOR PROPER DRAINAGE.

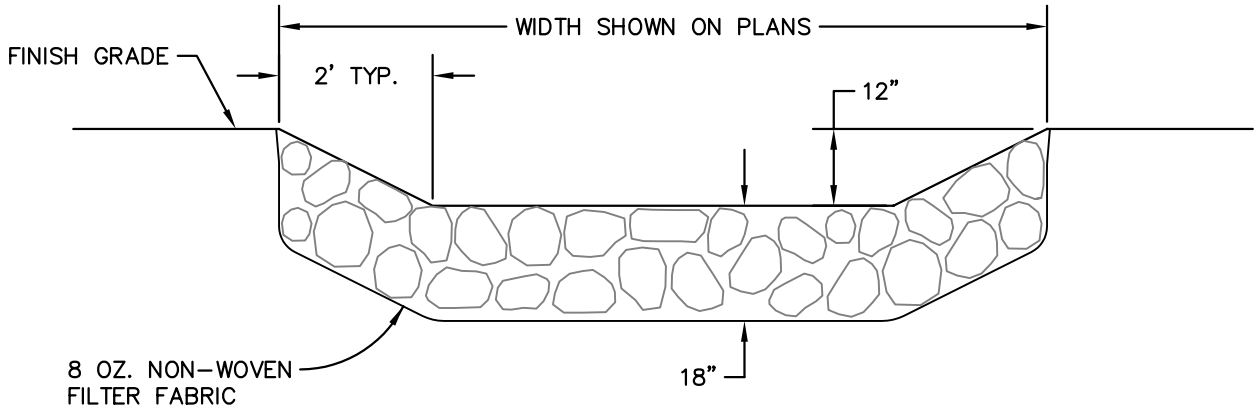
REFERENCE: Adapted from City of Austin & City of Tulsa Erosion and Sedimentation Control Manuals

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	DIVERSION DIKES & SWALES	ADOPTED: 10/15/02 SS–I11

PLANS TO SPECIFY WHETHER RIPRAP IS LOOSE OR GROUTED. THIS WILL VARY BY SPECIFIC PROJECT NEEDS.

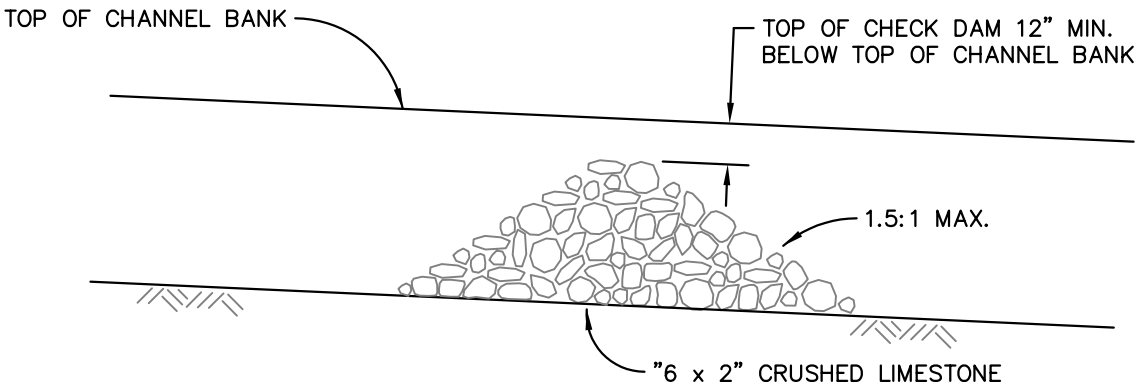


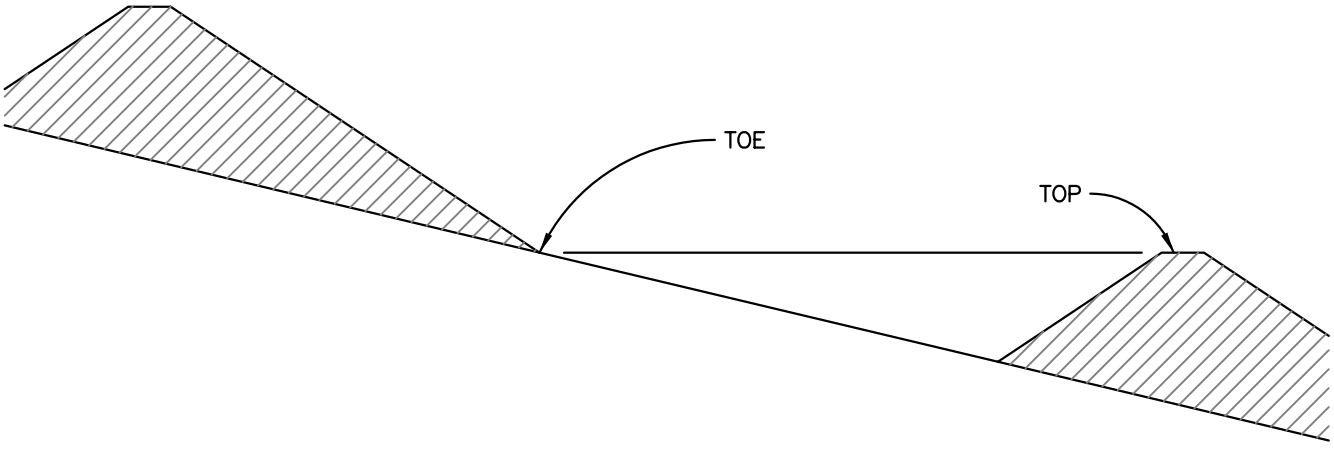
TYPICAL SECTION



SECTION A – A

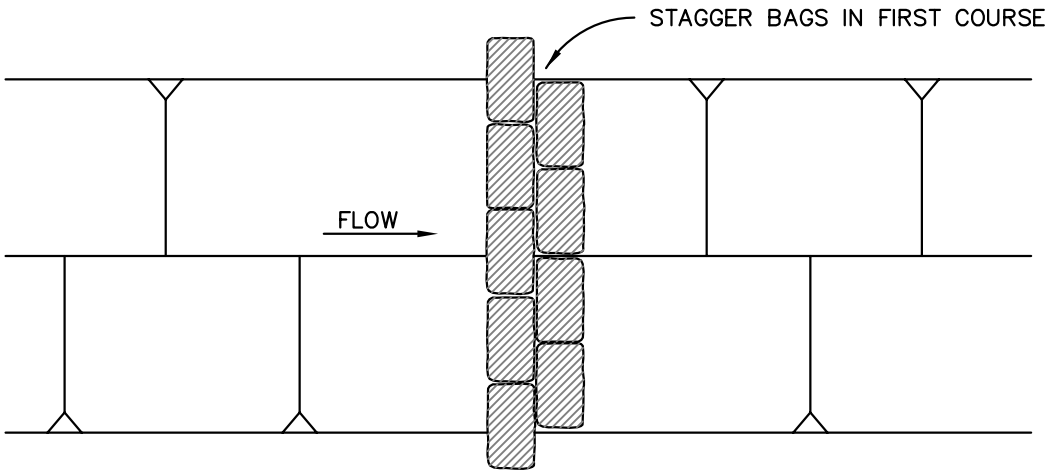
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	RIPRAP CHUTE CROSS-SECTION	ADOPTED: 10/15/02 SS-I12



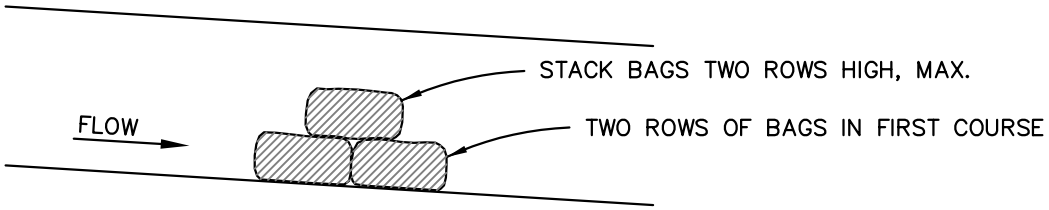


TYPICAL CHECK DAM SPACING

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	ROCK CHECK DAM	ADOPTED: 10/15/02 SS–I13



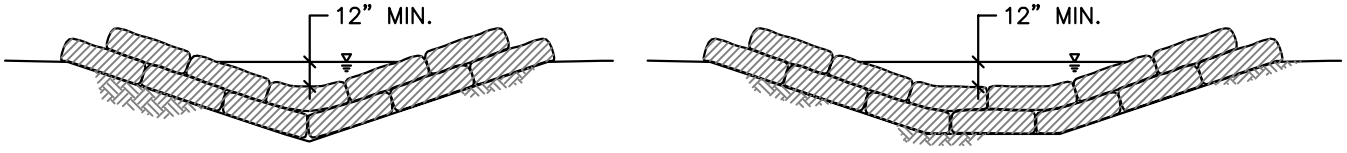
PLAN



PROFILE

NOTES:

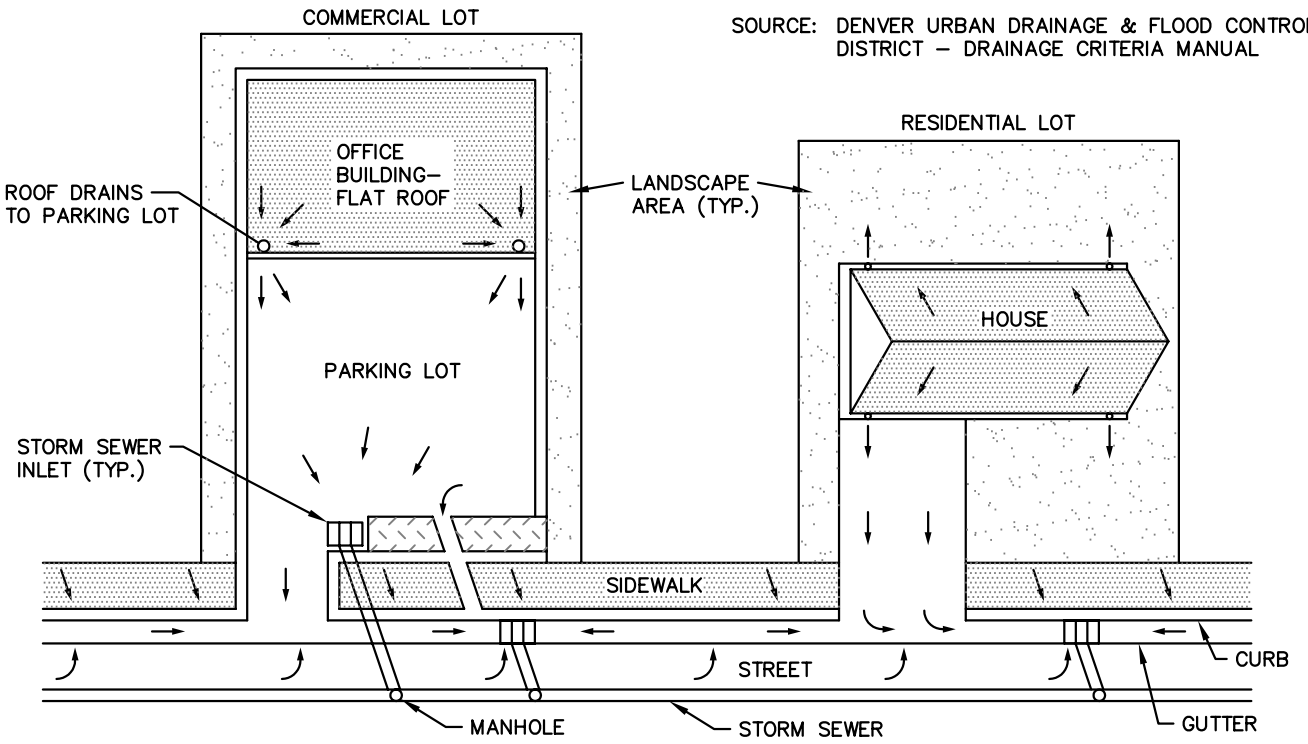
FILL BAGS WITH 5/8" TO 1 1/2" CRUSHED LIMESTONE.
BAGS MAY BE BURLAP OR WOVEN PLASTIC.
SPACE CHECK DAMS AS SHOWN IN FIG. SS–I13, OR AS SPECIFIED ON SEDIMENT & EROSION CONTROL PLAN.



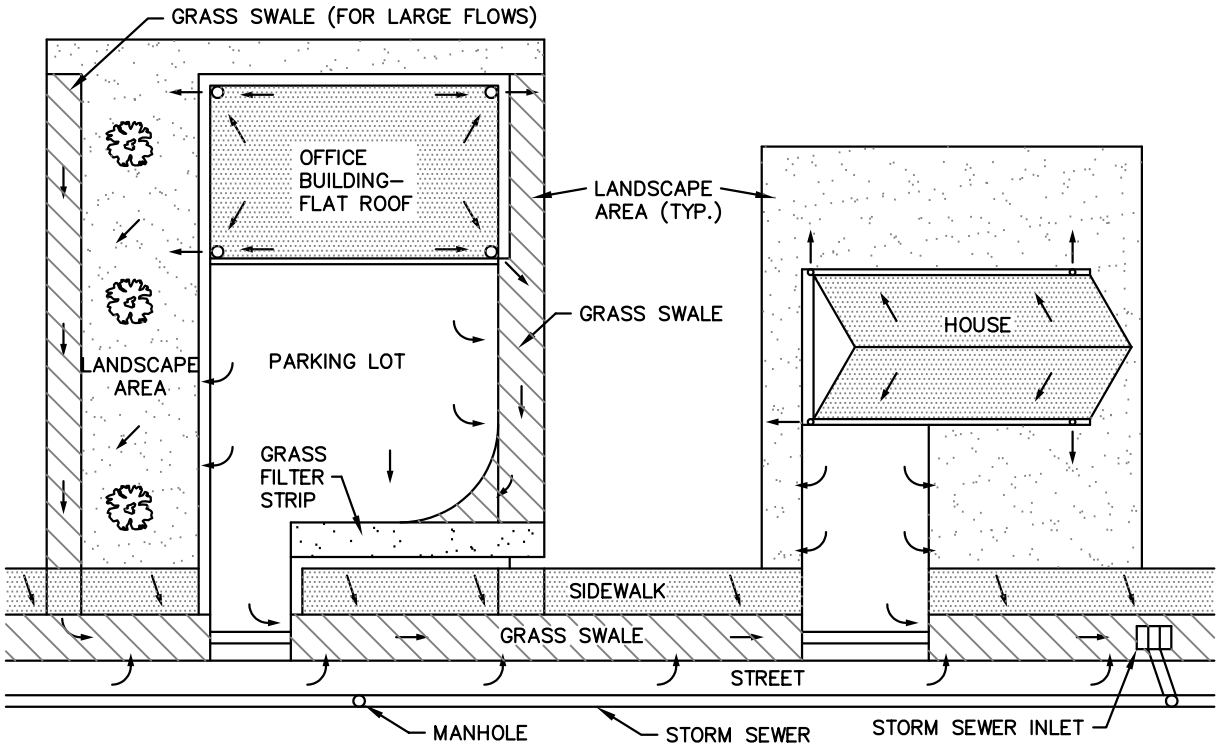
TYPICAL CROSS–SECTIONS

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	SANDBAG CHECK DAM	ADOPTED: 10/15/02 SS–I14

SOURCE: DENVER URBAN DRAINAGE & FLOOD CONTROL DISTRICT – DRAINAGE CRITERIA MANUAL

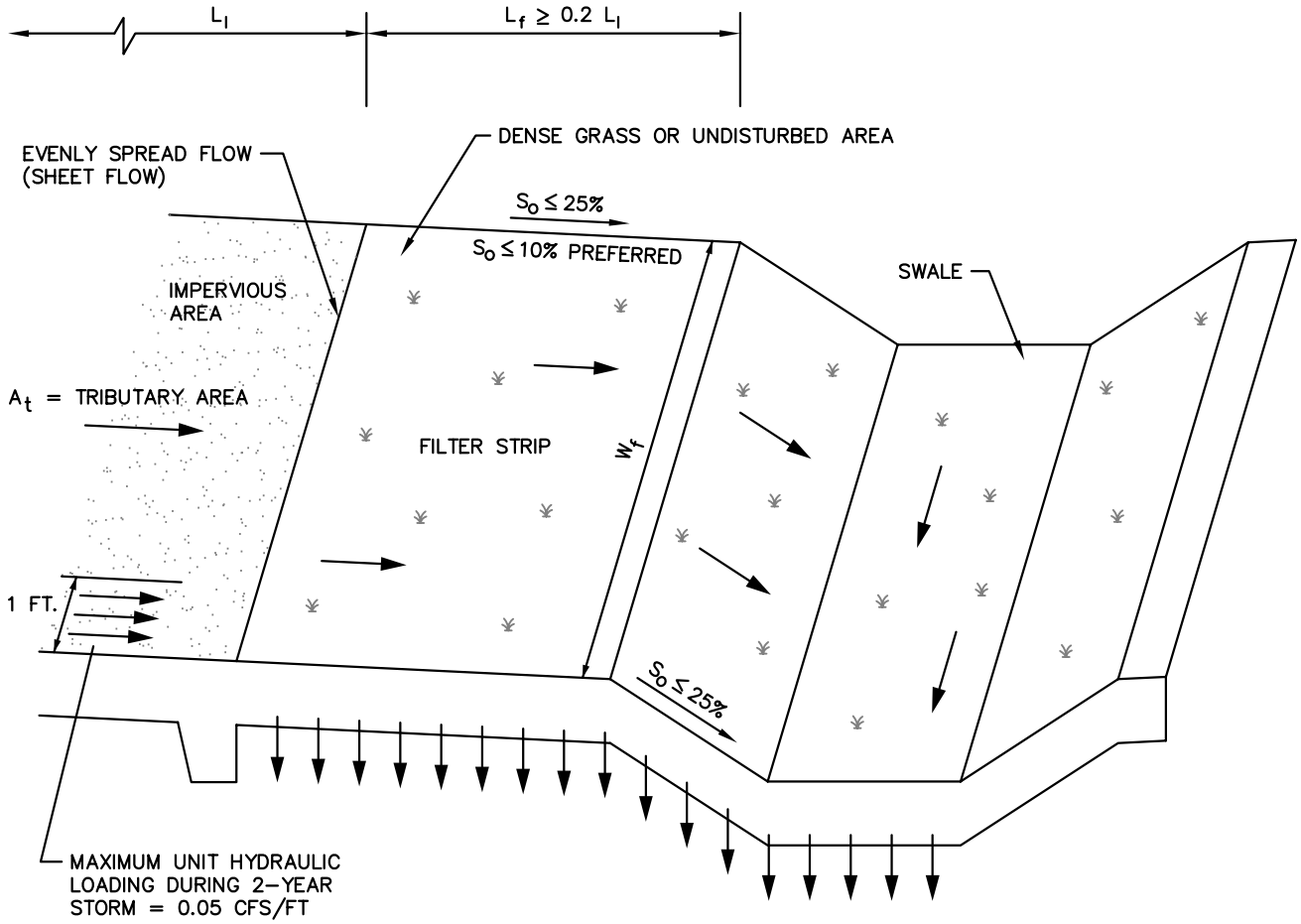


TRADITIONAL SITE & STREET DRAINAGE DESIGN



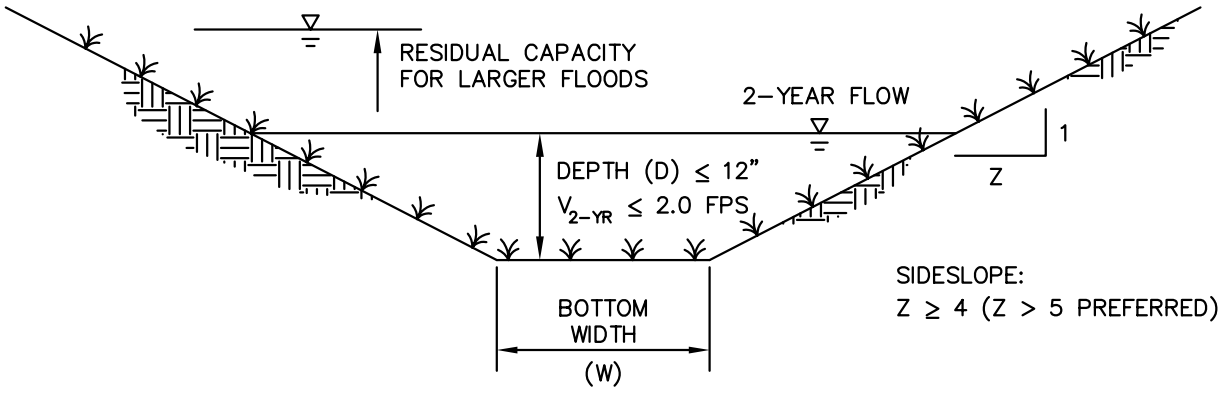
MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MINIMIZING DIRECTLY CONNECTED IMP AREAS	ADOPTED: 10/15/02 SS–J1

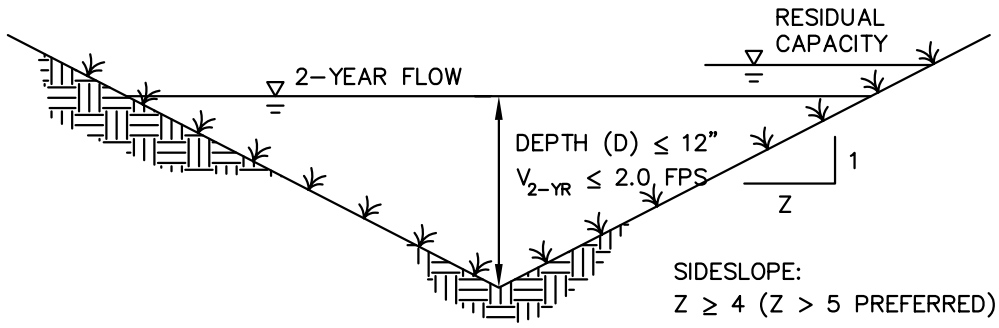


ADAPTED FROM DENVER URBAN DRAINAGE & FLOOD CONTROL DISTRICT – DRAINAGE CRITERIA MANUAL

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	VEGETATIVE FILTER STRIP WATER QUALITY BMP	ADOPTED: 10/15/02 SS–J2



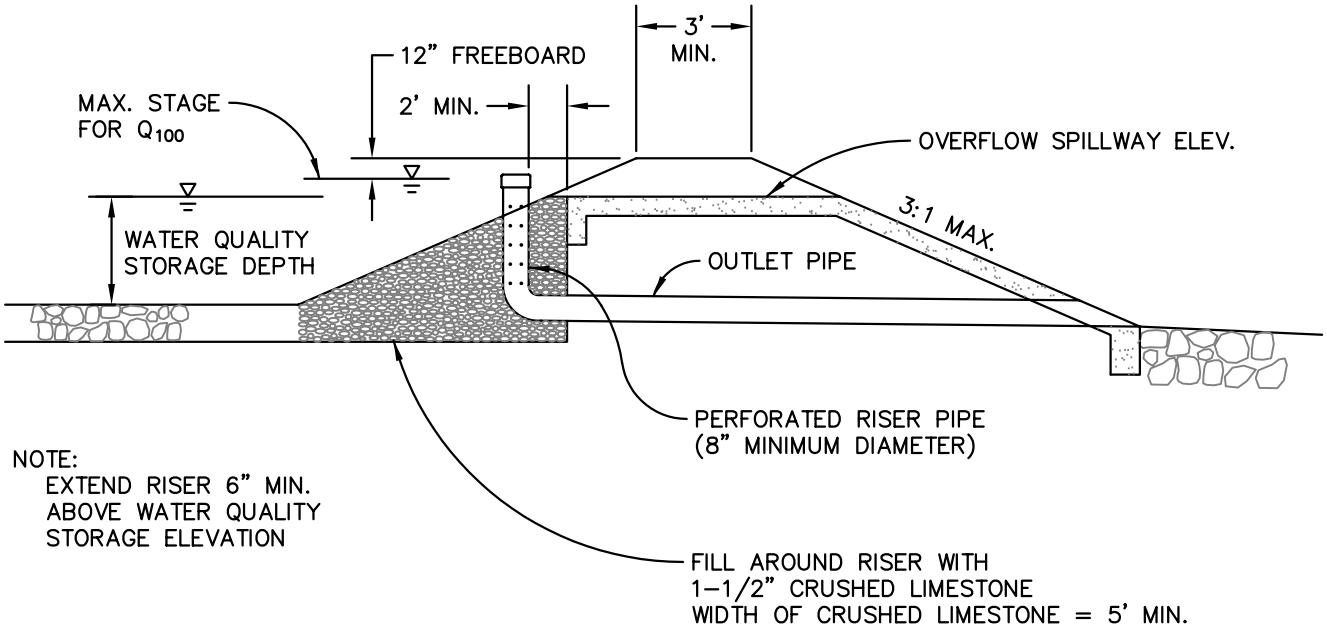
TRAPEZOIDAL GRASS-LINED SWALE SECTION



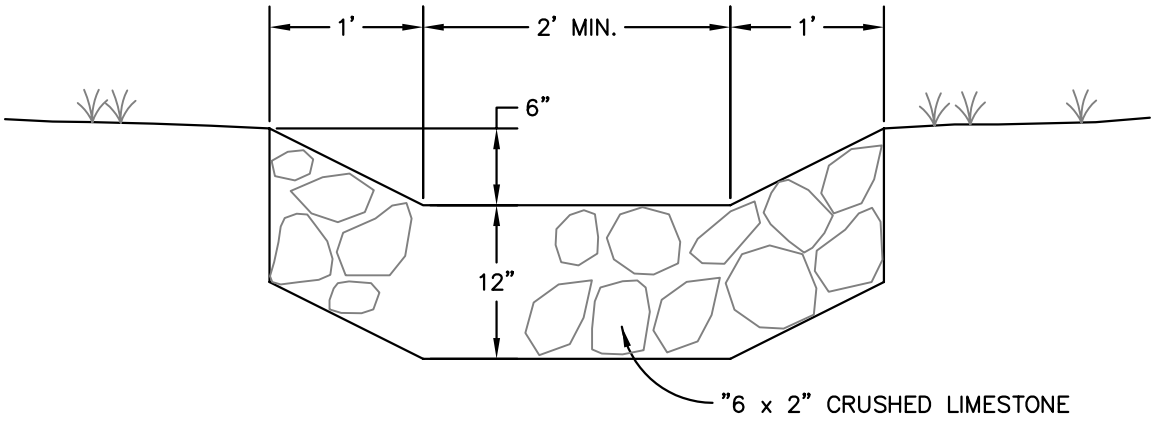
TRIANGULAR GRASS-LINED SWALE SECTION

ADAPTED FROM DENVER URBAN DRAINAGE & FLOOD CONTROL DISTRICT – DRAINAGE CRITERIA MANUAL

CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	GRASS SWALE WATER QUALITY BMP	ADOPTED: 10/15/02 SS-J3



CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	EXT DRY DETENTION DAM & OUTLET	ADOPTED: 10/15/02 SS-J4



CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	TRICKLE CHANNEL FOR EXTENDED DRY BASINS	ADOPTED: 10/15/02 SS–J5

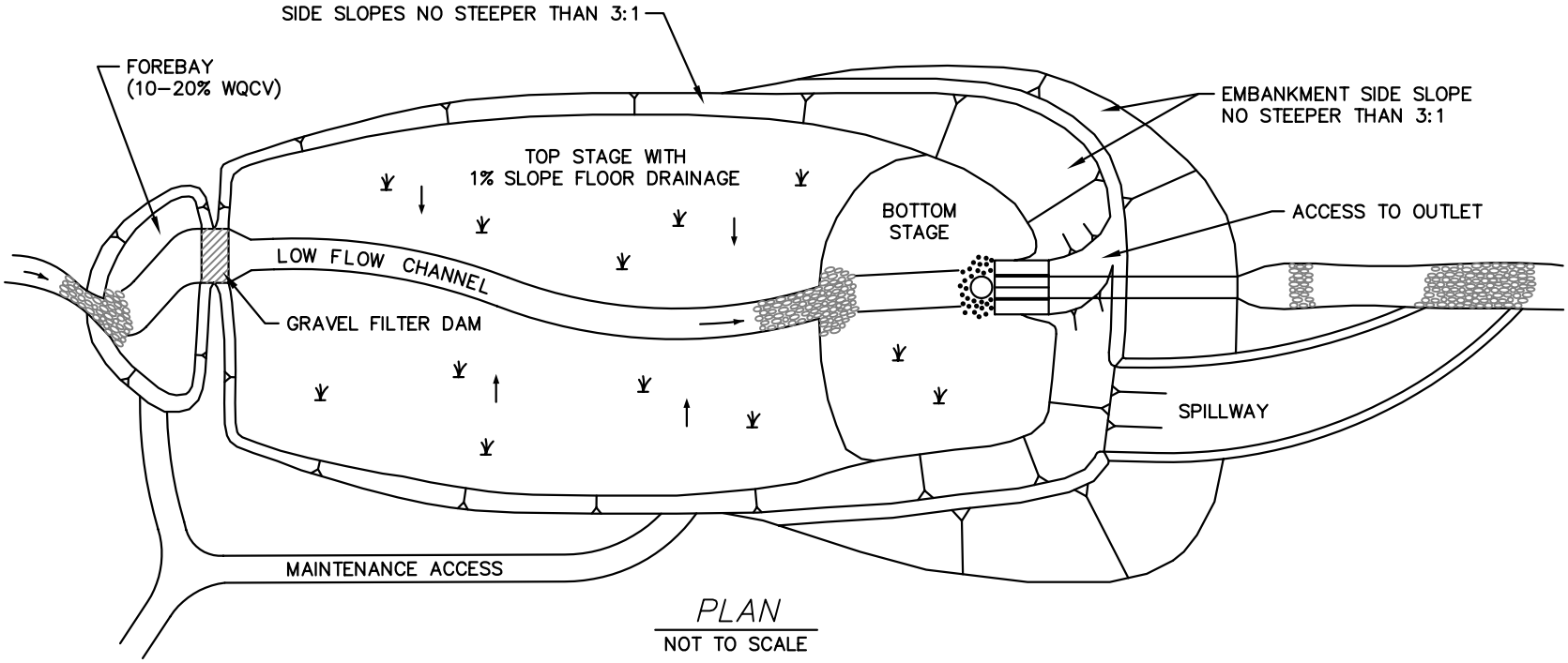
CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

SCHEMATIC PLAN OF A EXTD DRY DETENTION

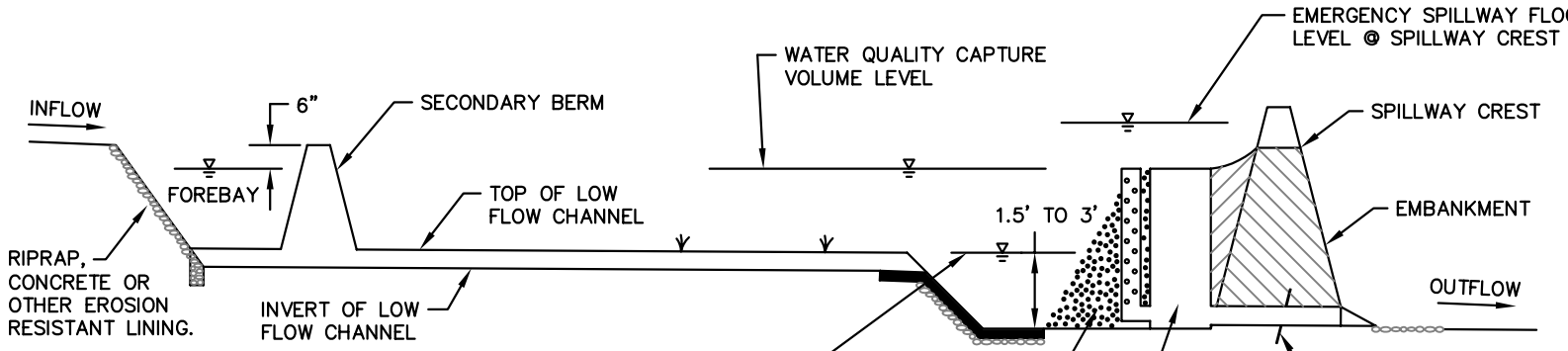
ADOPTED: 10/15/02

SS–J6

ADAPTED FROM DENVER URBAN DRAINAGE & FLOOD CONTROL DISTRICT – DRAINAGE CRITERIA MANUAL



PLAN
NOT TO SCALE



SECTION
NOT TO SCALE

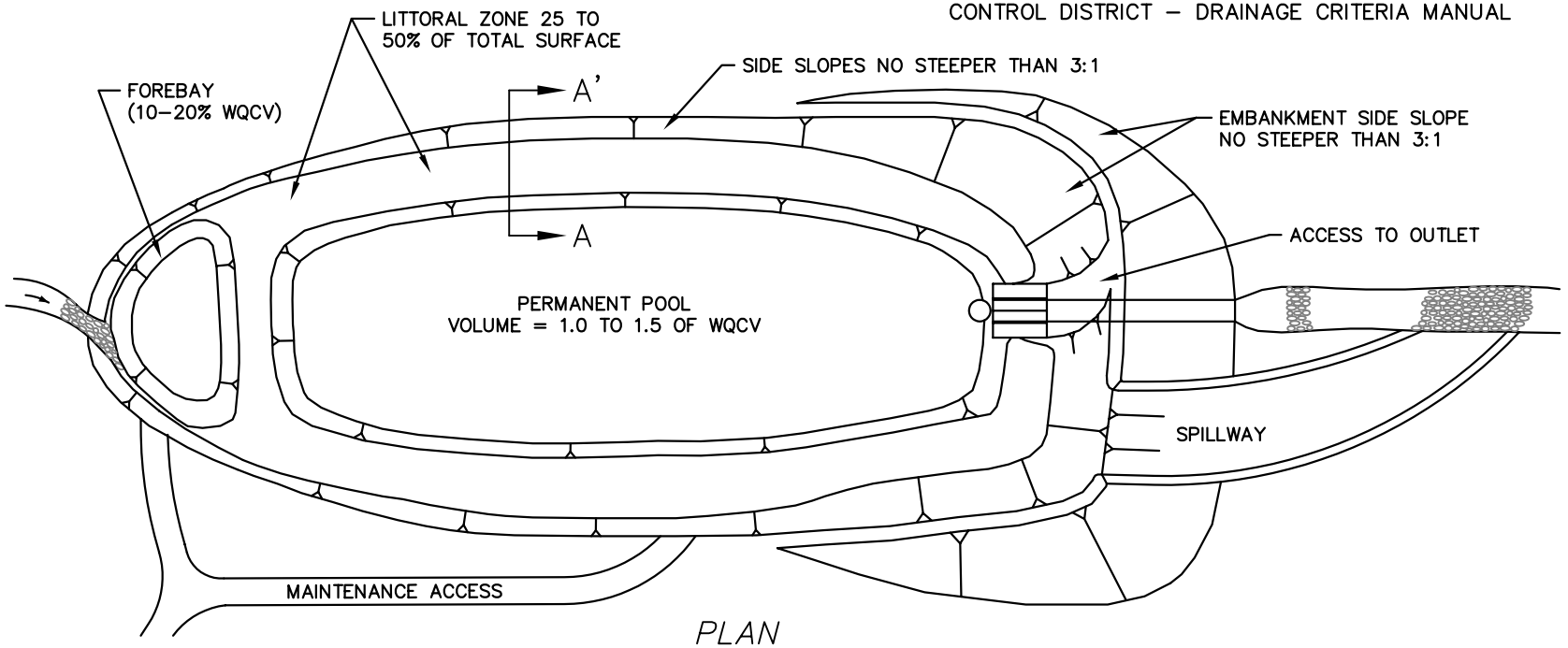
CITY OF BATTLEFIELD
STANDARD DRAWINGS AND FIGURES

SCHEMATIC PLAN OF A EXTD WET DETENTION

ADOPTED: 10/15/02

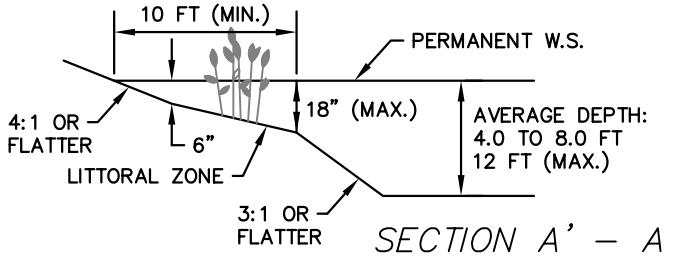
SS-J7

ADAPTED FROM DENVER URBAN DRAINAGE & FLOOD CONTROL DISTRICT – DRAINAGE CRITERIA MANUAL

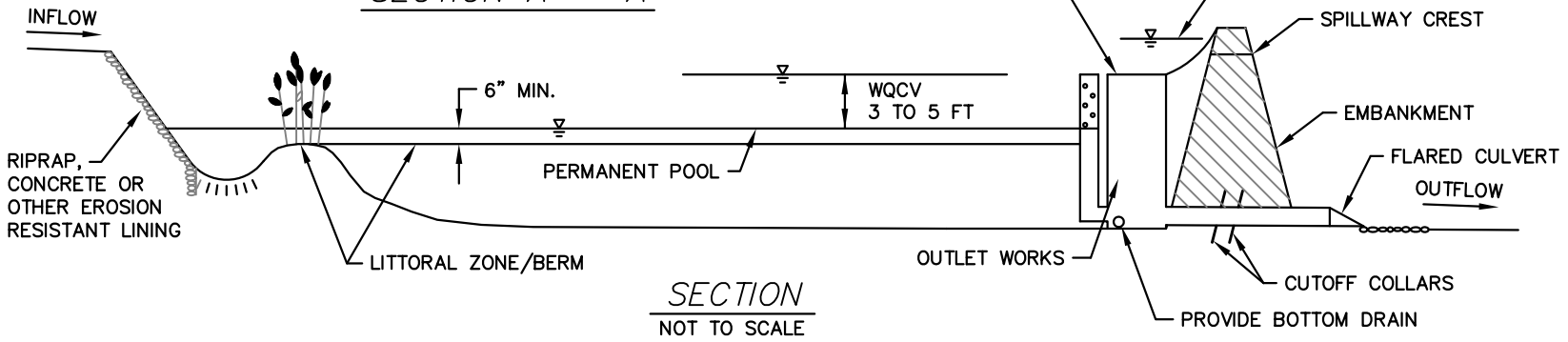


PLAN

NOT TO SCALE

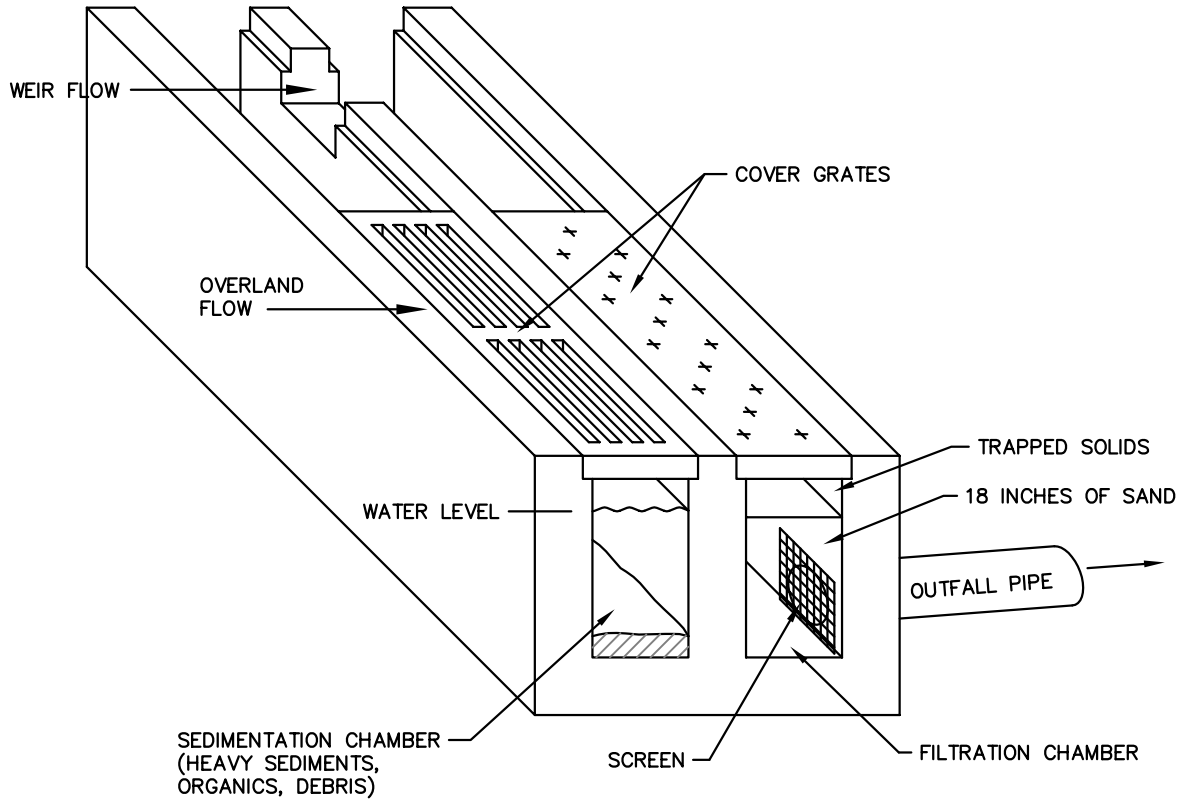


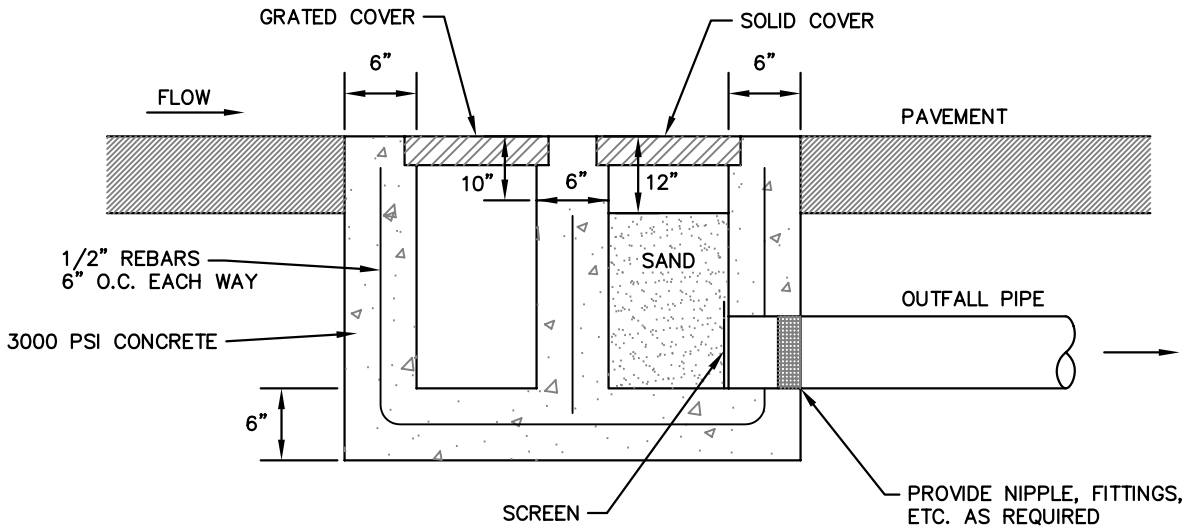
SECTION A' – A



SECTION

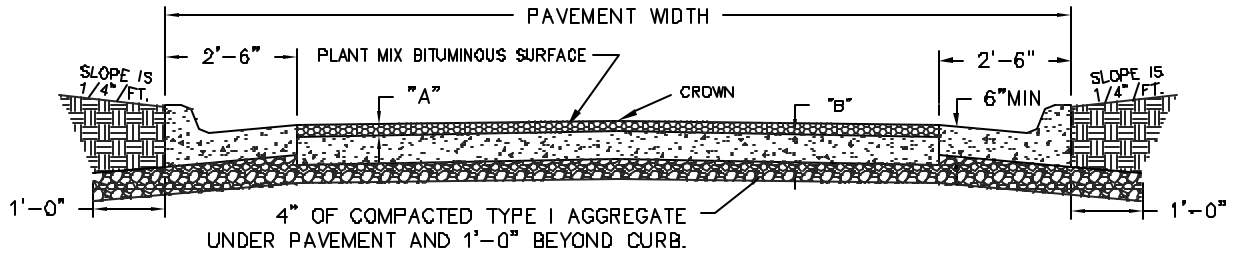
NOT TO SCALE



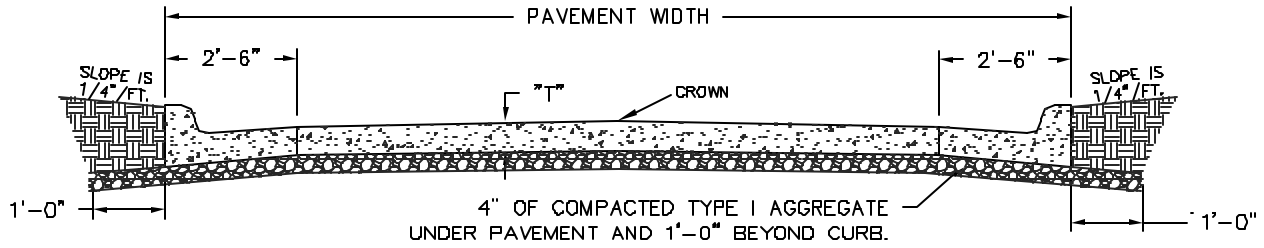


FROM: EPA 1992

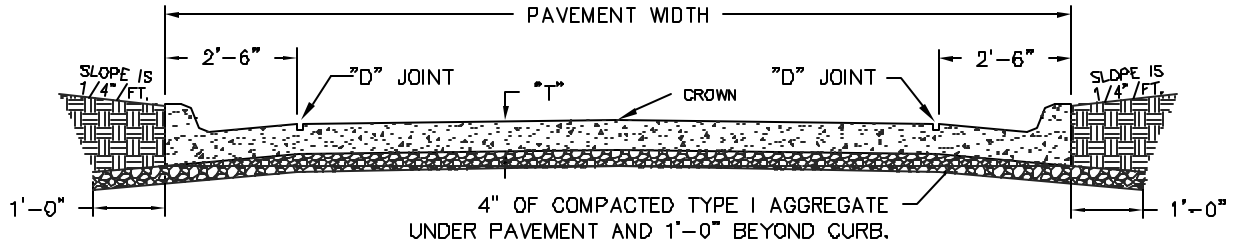
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	SAND FILTER SCHEMATIC	ADOPTED: 10/15/02 SS–J8



BITUMINOUS CONCRETE PAVEMENT WITH CONCRETE CURB & GUTTER



PORTLAND CEMENT CONCRETE PAVEMENT AND CONCRETE CURB & GUTTER



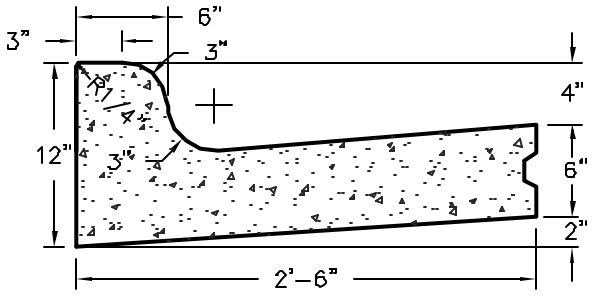
PORTLAND CEMENT CONCRETE PAVEMENT WITH INTEGRAL CURB

STANDARD PAVEMENT WIDTH AND THICKNESS			
STREET TYPE	"T"	"A"	"B"
ALLEY	6"	1+1/2"	4+1/2"
LOCAL	6"	1+1/2"	5+1/2"
RESIDENTIAL, COLLECTOR	7"	1+1/2"	7"
COLLECTOR, 2ND ARTERIAL, & HIGHER	TO BE INDIVIDUALLY DETERMINED BY 20 YR. TRAFFIC PROJECTION		

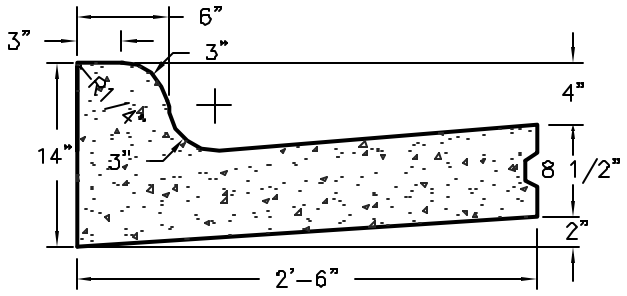
NOTES: CROSS SLOPE SHALL BE 1/4"/FT. ON ALL PAVEMENTS EXCEPT ALLEYS, SEE STANDARD DRAWING ST-4.

WIDTH OF PAVEMENT IS SUBJECT TO REQUIREMENTS OF THE PLANNING DEPARTMENT AND MAY VARY FROM THE STANDARDS.

TO CREATE A GUTTER SECTION THE CONTRACTOR SHALL FORM A 2" RISE 2' FROM THE INSIDE OF THE CURB. PAVEMENT WIDTH WILL BE MEASURED FROM BACK OF CURBS ON IMPROVED STREETS. PAVEMENT CROWN SHOULD BE CENTERED IN RIGHT OF WAY.

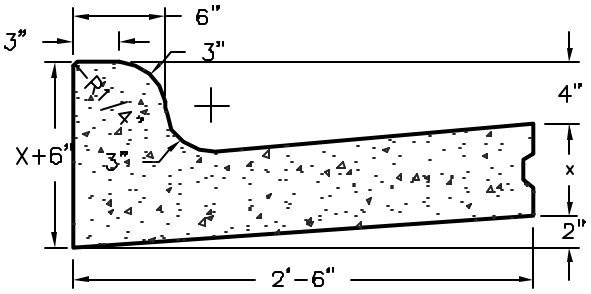


LOCAL STREETS & ALLEYS



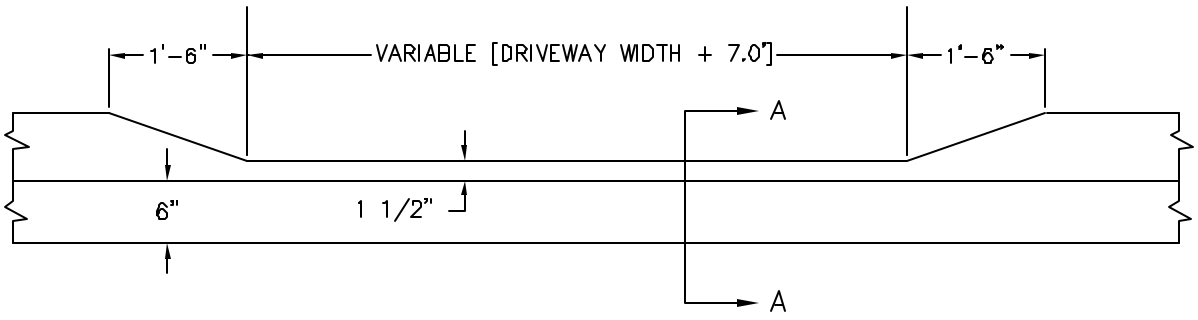
RESIDENTIAL, AND
COLLECTOR STREETS

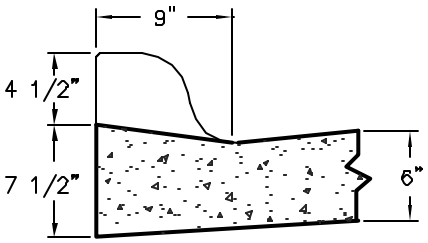
NOTE: KEYWAY OR #5 REBAR @ 2'6" O.C. TO BE USED ON ALL CONCRETE PAVEMENT. ASPHALT PAVEMENT – DOWELL AND KEYWAY SHALL BE OMITTED.



COLLECTOR, 2ND ARTERIAL & HIGHER
X TO MATCH PAVEMENT THICKNESS

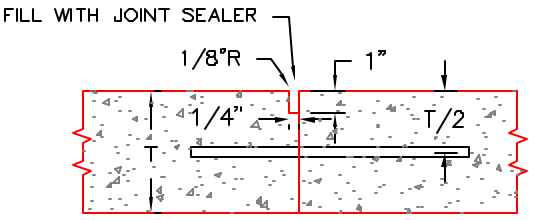
STANDARD RESIDENTIAL DRIVEWAY OPENING





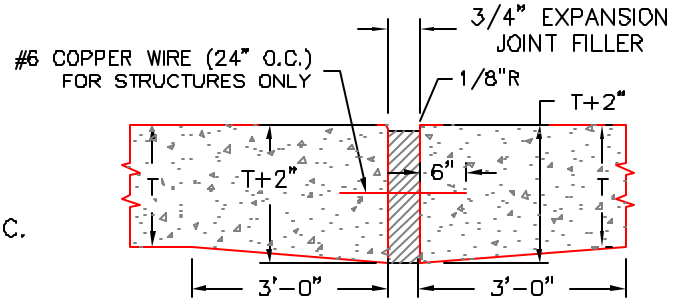
SECTION A–A

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB & GUTTER / DRIVEWAY OPENING	ADOPTED: 10/15/02 ST–2



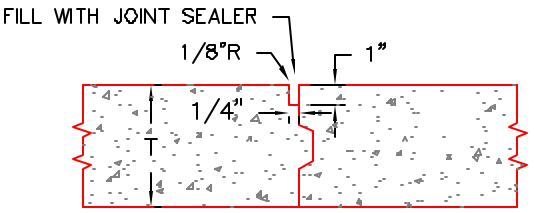
DOWELED LONGITUDINAL JOINT
WITH 24" No.6 DEFORMED BAR AT 24" O.C.

TYPE "A"



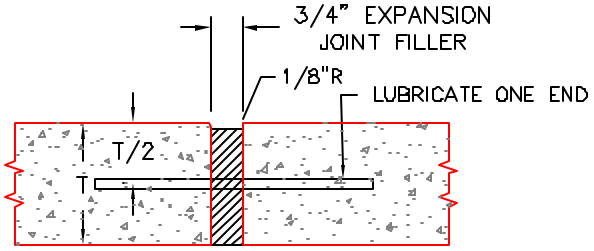
EXPANSION JOINT

TYPE "E"



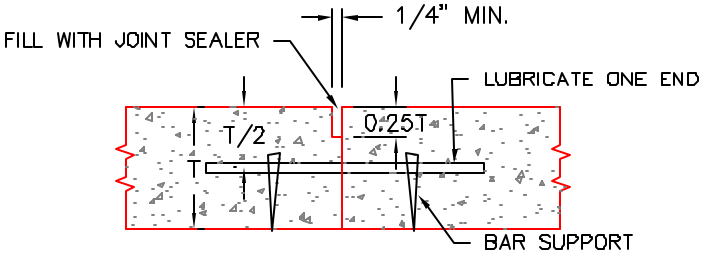
KEYED LONGITUDINAL JOINT

TYPE "B"



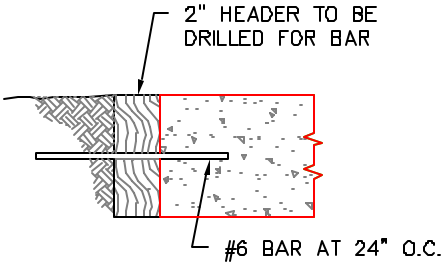
DOWELED EXPANSION JOINT
3/4" x 15" DOWEL BAR AT 24" O.C.

TYPE "F"

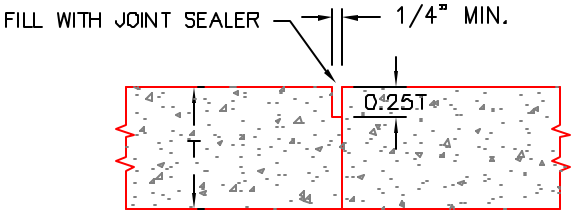


SAWED CONTRACTION JOINT WITH
1" x 18" DOWEL BAR AT 24" O.C.

TYPE "C"



CONSTRUCTION HEADER CONCRETE



SAWED CONTRACTION JOINT

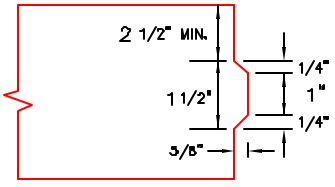
TYPE "D"

DEPTH OF SAW JOINT

6" PAV. = 1 1/2"

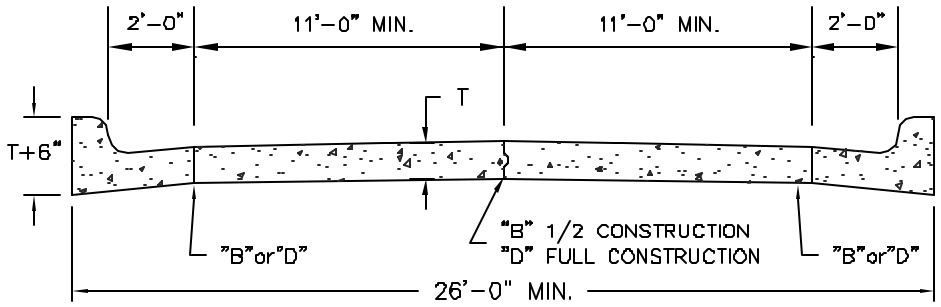
7" PAV. = 1 3/4"

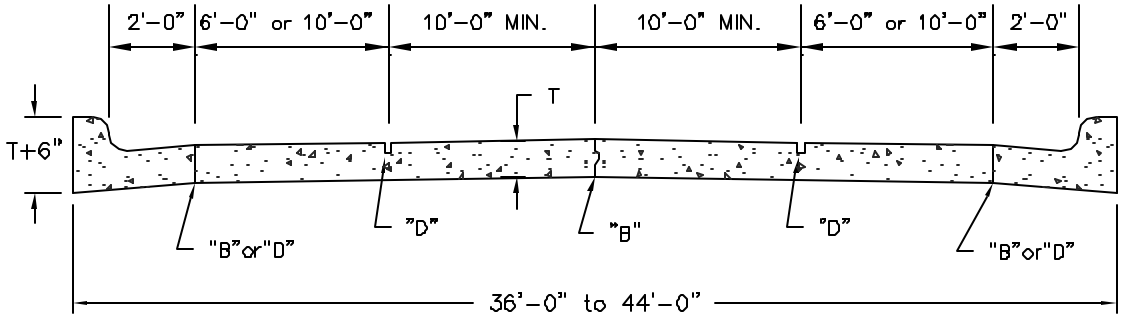
8" PAV. = 2"



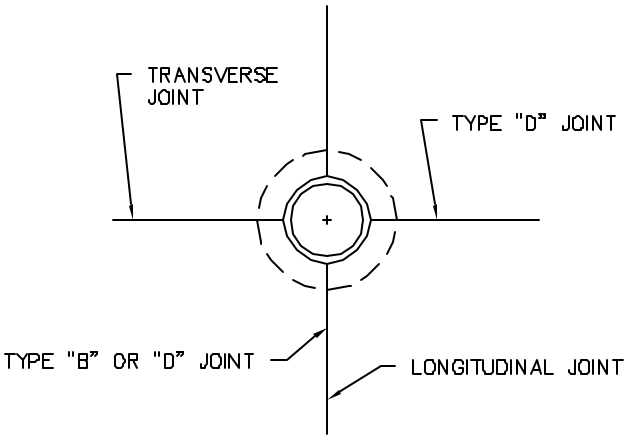
DETAIL KEY
KEYWAY FORMED BY FASTENING KEY TO FORM

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	JOINT DETAILS – CONCRETE PAVEMENT	ADOPTED: 10/15/02 ST–3

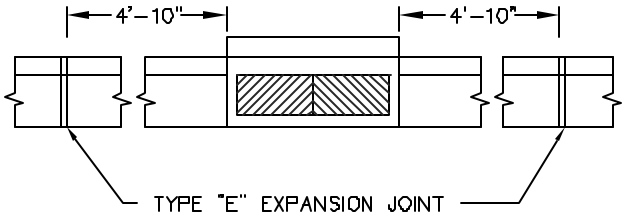




CONCRETE PAVEMENT – JOINT LOCATIONS

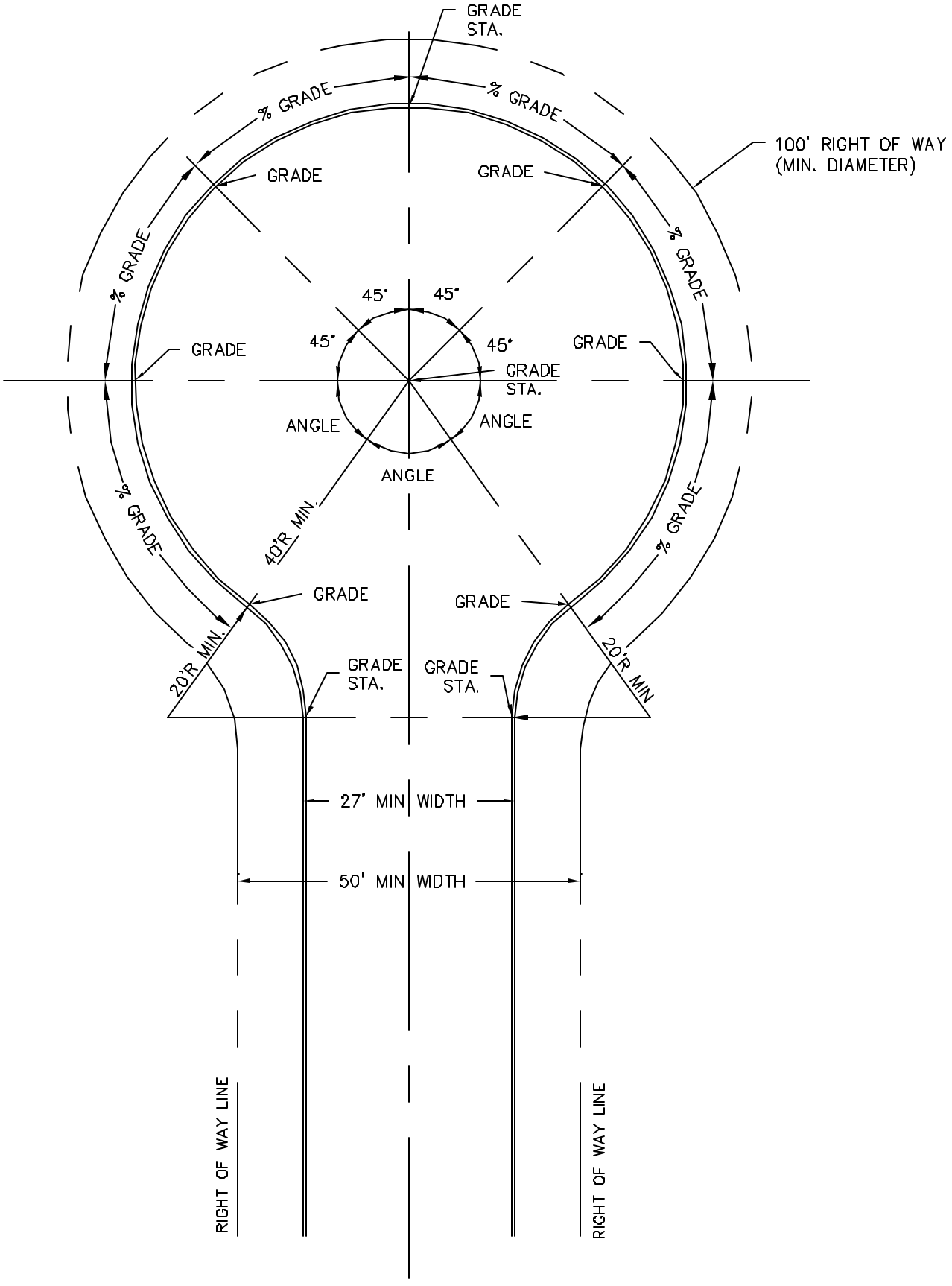


MANHOLE JOINT DETAIL



JOINT LOCATION AT INLETS

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	JOINT LOCATION – CONCRETE PAVEMENT	ADOPTED: 10/15/02 ST–4

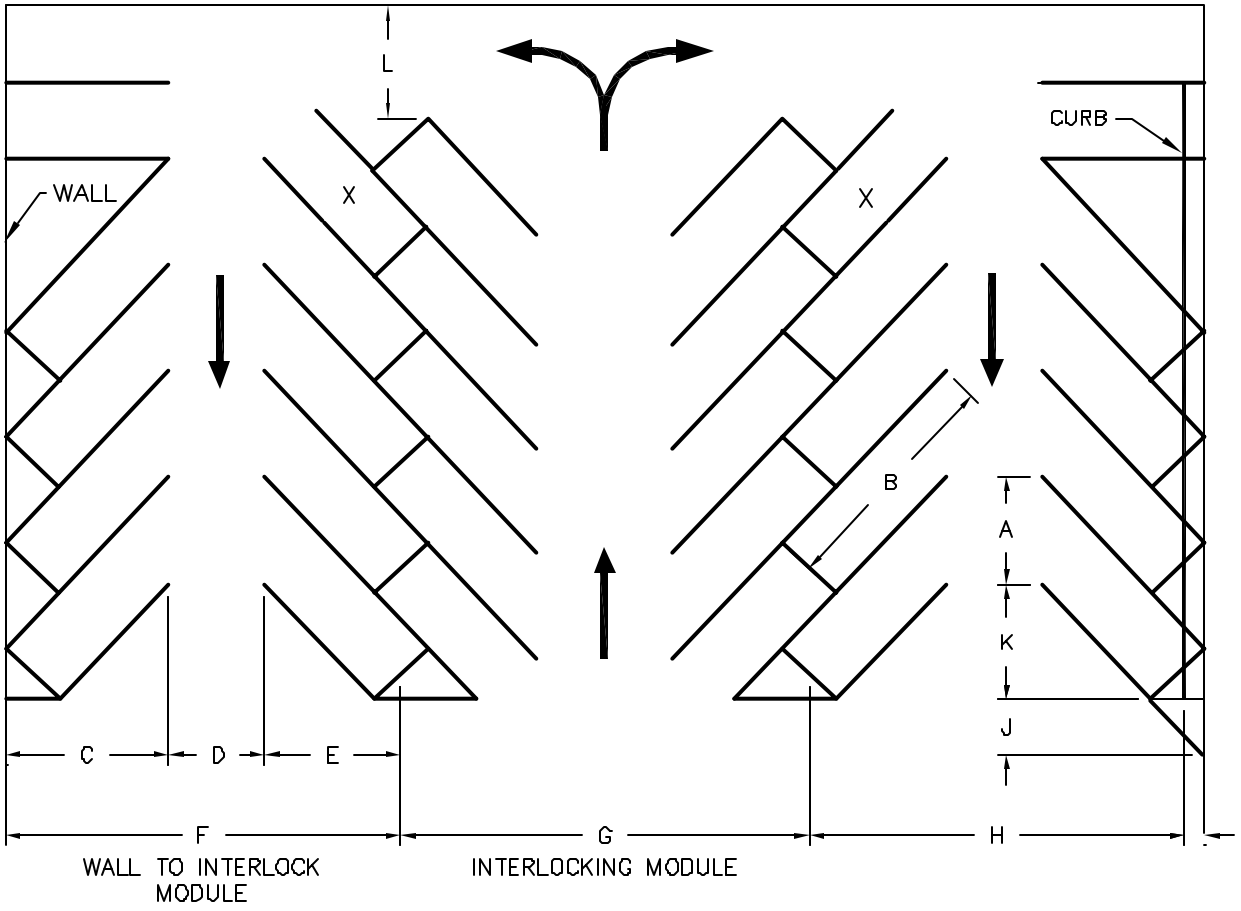


NOTE: MAXIMUM LENGTH OF CUL-DE-SAC SHALL BE 800 FEET.

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	STANDARD CUL-DE-SAC	ADOPTED: 10/15/02 ST-5

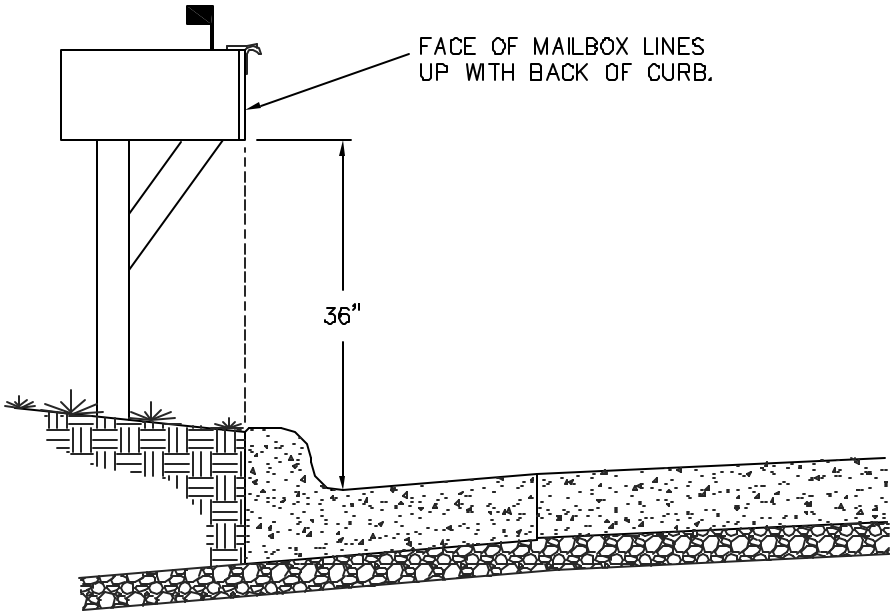
MINIMUM REQUIREMENTS FOR LAYOUT ELEMENTS

X DENOTES THAT STALL NOT ACCESSIBLE IN CERTAIN LAYOUTS

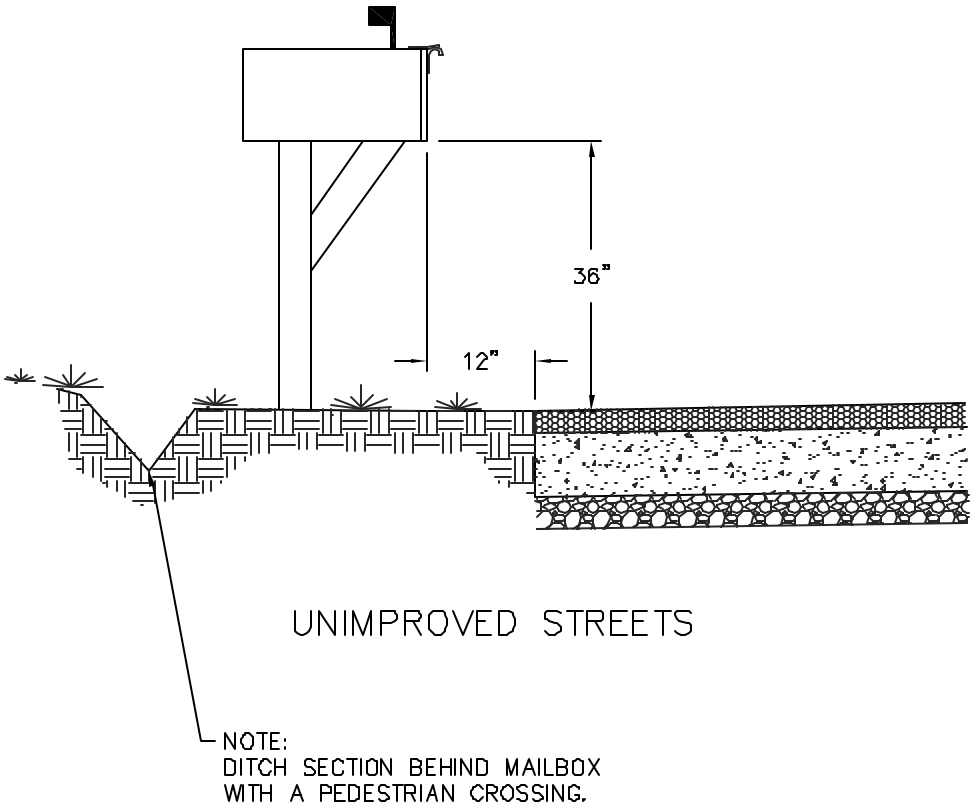


PARKING LAYOUT DIMENSIONS (IN FEET) FOR 9 FT. STALLS AT VARIOUS ANGLES

DIMENSION	SYMBOL	90°	75°	60°	45°	30°
STALL WIDTH, PARALLEL TO AISLE	A	9.0	9.3	10.4	12.7	18.0
STALL LENGTH OF LINE	B	18.5	20.0	22.0	25.0	34.1
STALL DEPTH TO WALL	C	18.5	19.5	19.0	17.5	17.1
AISLE WIDTH BETWEEN STALL LINES	D	26.0	23.0	16.0	12.0	10.0
STALL DEPTH, INTERLOCK	E	18.5	18.8	17.5	15.3	13.2
MODULE, WALL TO INTERLOCK	F	63.0	61.3	52.5	44.8	40.3
MODULE, INTERLOCKING	G	63.0	61.0	51.0	42.6	36.4
MODULE, INTERLOCK TO CURB FACE	H	60.5	58.8	50.2	42.8	38.8
BUMPER OVERHANG (TYPICAL)	I	2.5	2.5	2.3	2.0	1.5
OFFSET	J	0.0	0.5	2.7	6.3	13.5
SETBACK	K	0.0	5.0	8.3	11.0	16.0
CROSS AISLE, ONE-WAY	L	14.0	14.0	14.0	14.0	14.0
CROSS AISLE, TWO-WAY	–	24.0	24.0	24.0	24.0	24.0

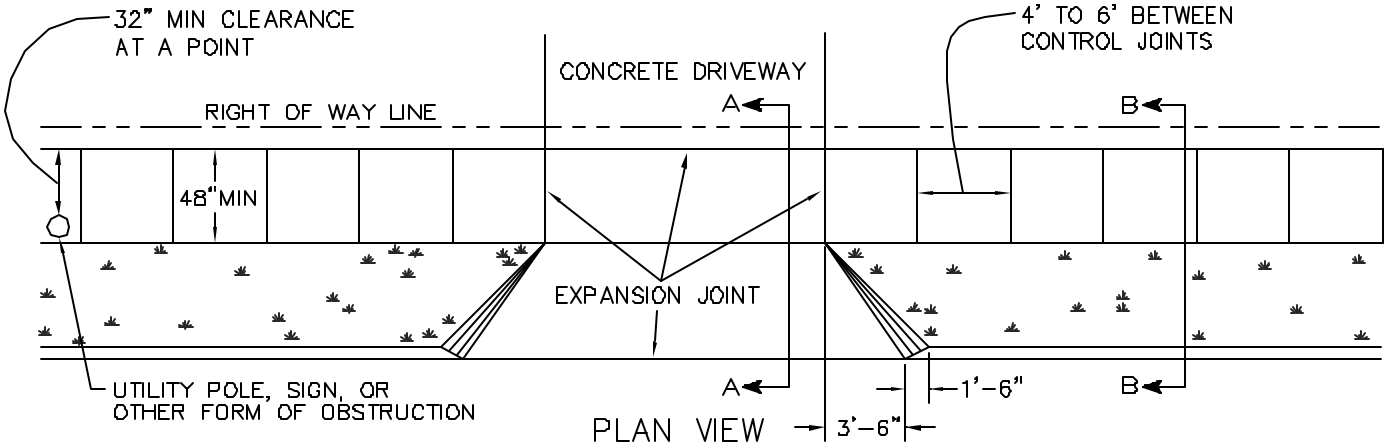


IMPROVED STREETS

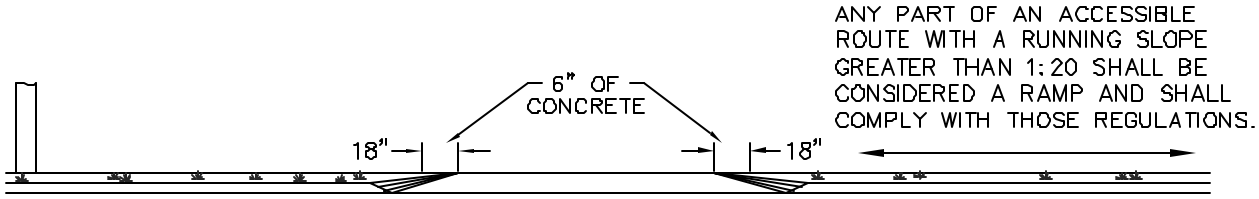


UNIMPROVED STREETS

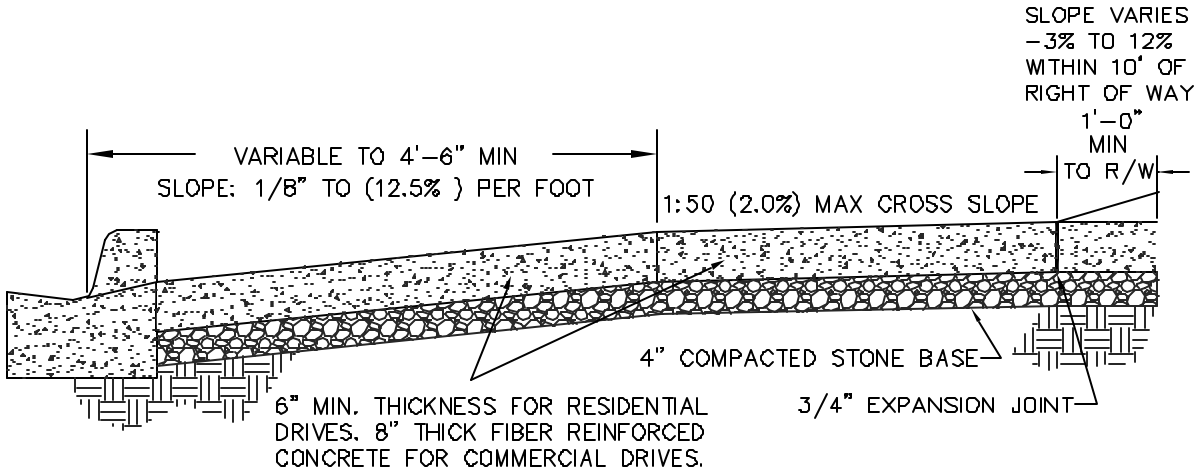
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MAILBOX REPLACEMENT	ADOPTED: 10/15/02 ST–7



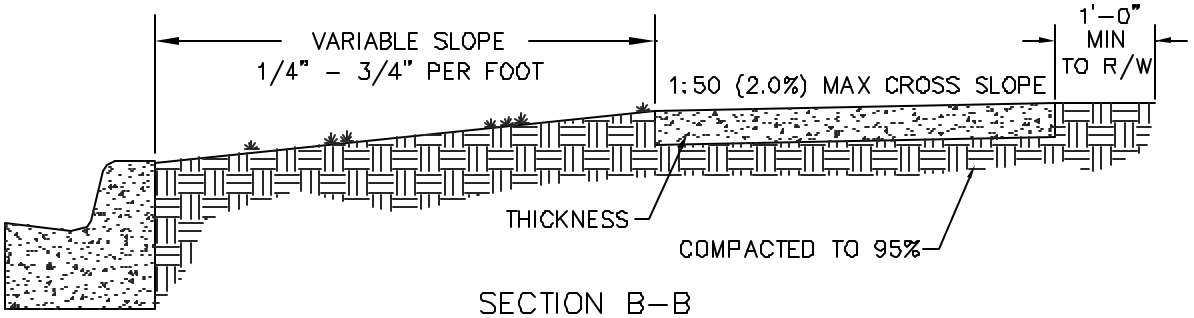
PLAN VIEW



TYPICAL ELEVATION WITH NO RAMPING

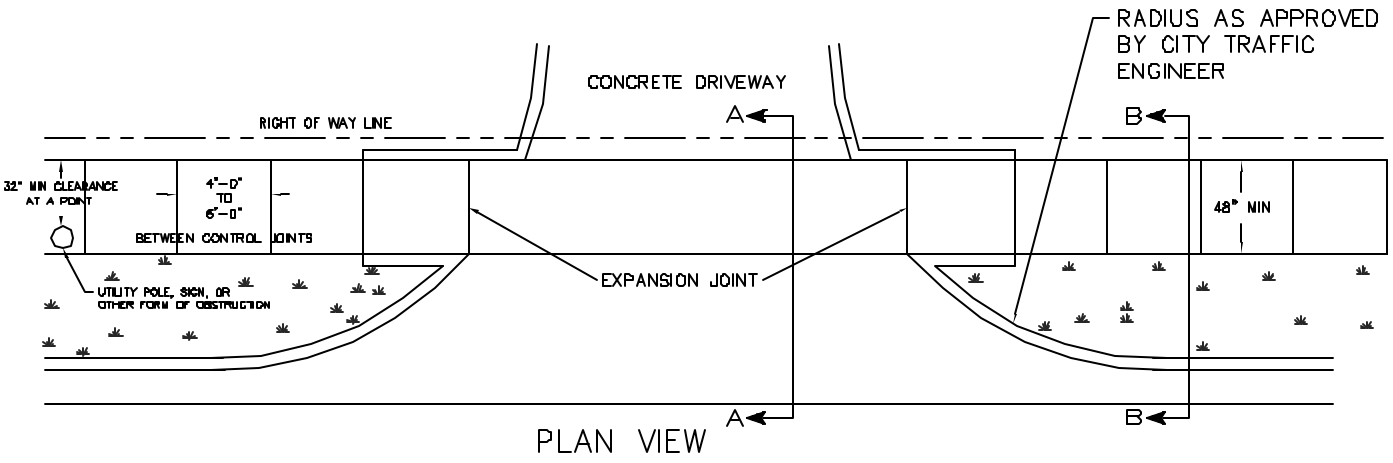


SECTION A-A

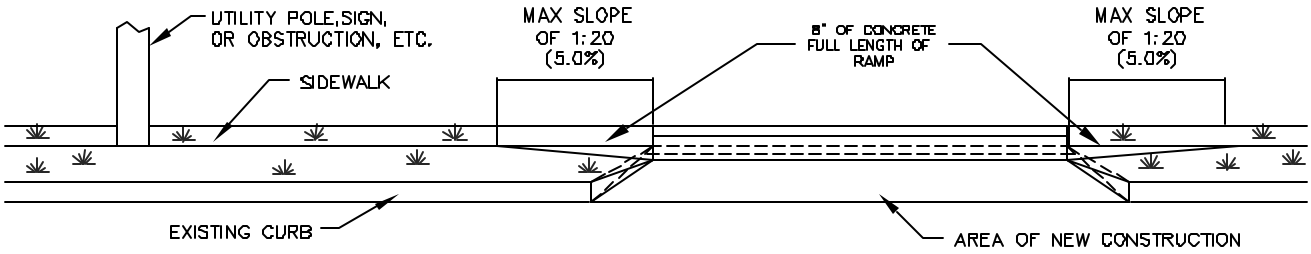


SECTION B-B

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**TYPICAL RESIDENTIAL DRIVEWAY & SIDEWALK**	ADOPTED: 10/15/02 ST-8

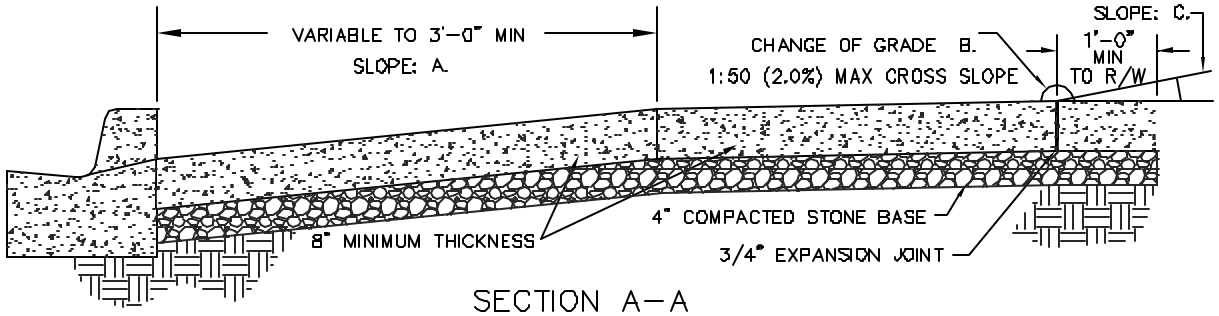


PLAN VIEW

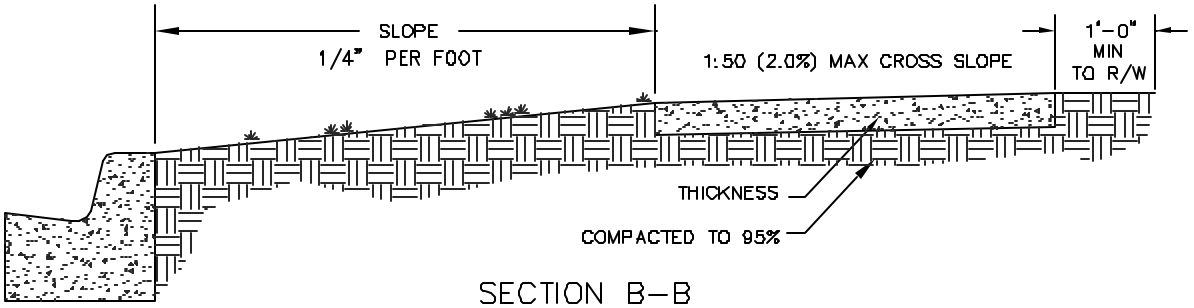


TYPICAL ELEVATION WITH RAMPING

REQUIRED DRIVEWAY GRADES				
	MAJOR ARTERIAL	SECONDARY ARTERIAL	COLLECTOR ARTERIAL	NON-RESIDENTIAL LOCAL
A. DRIVEWAY APPROACH GRADE	2% to 4% 1/4in/ft to 1/2in/ft	2% to 5% 1/4in/ft to 5/8in/ft	2% to 6% 1/4in/ft to 3/4in/ft	2% to 8% 1/4in/ft to 1in/ft
B. MAXIMUM CHANGE OF GRADE AT BACK OF SIDEWALK	4%	5%	6%	8%
C. SLOPE WITHIN 20 FEET OF RIGHT-OF-WAY LINE	-2% to 6% 1/4in/ft to 3/4in/ft	-3% to 7% -3/8in/ft to 7/8in/ft	-4% to 8% -1/2in/ft to 1in/ft	-6% to 10% -3/4in/ft to 1-1/4in/ft



SECTION A-A

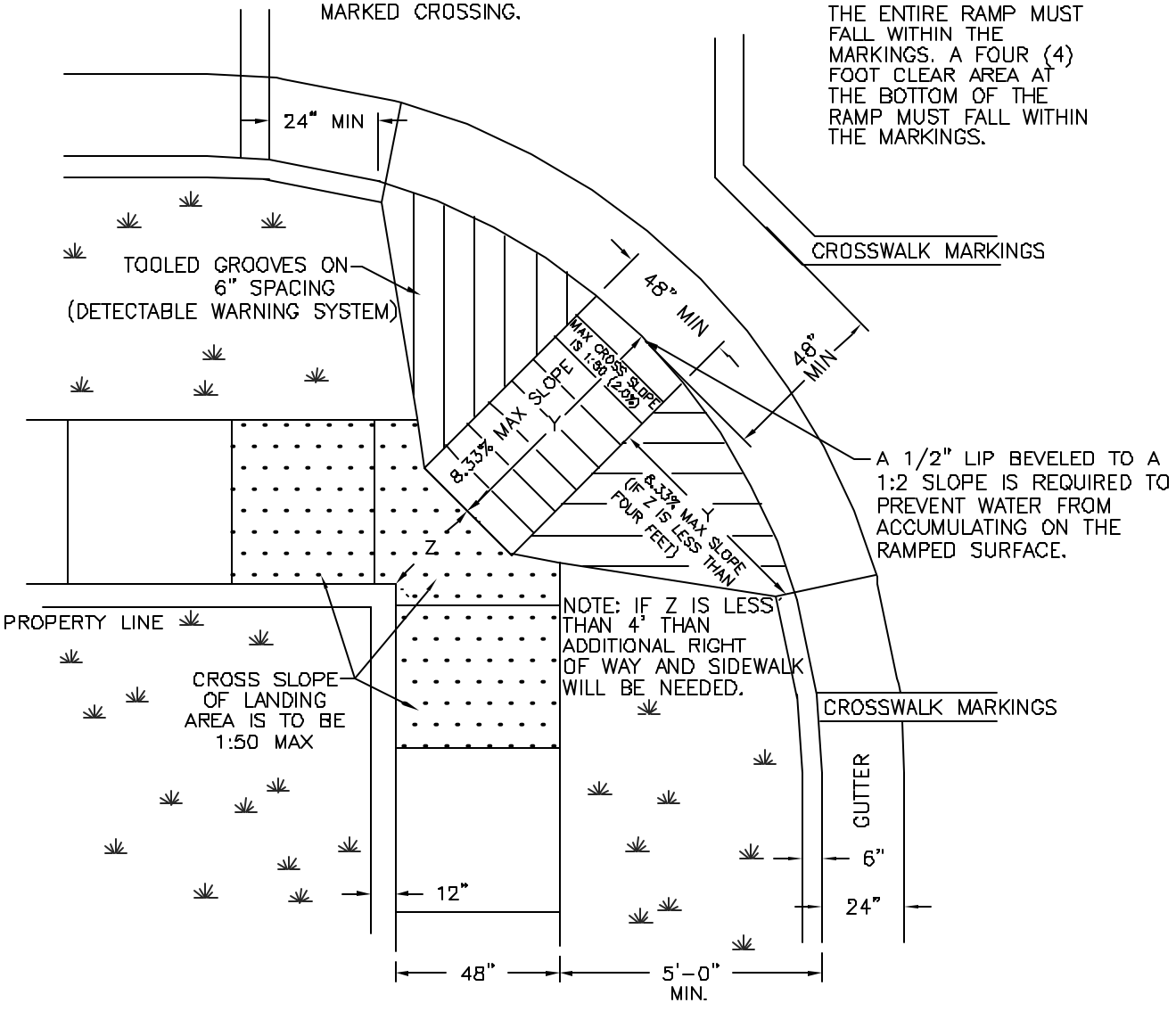


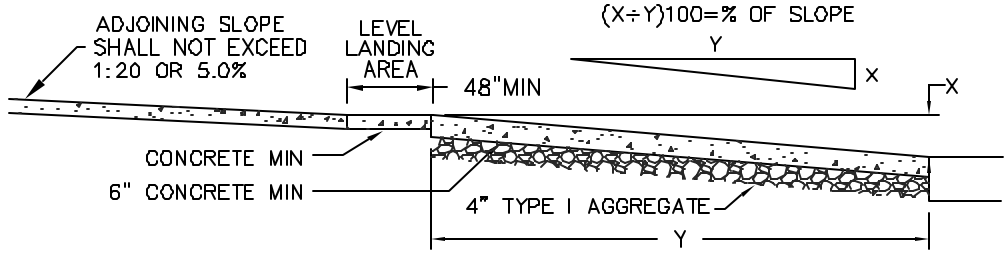
SECTION B-B

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	**TYPICAL COMMERCIAL DRIVEWAY & SIDEWALK**	ADOPTED: 10/15/02 ST-9

NOTE: IF DIAGONAL CURB RAMPS HAVE FLARED SIDES, THEY SHALL ALSO HAVE AT LEAST A 24" LONG SEGMENT OF STRAIGHT CURB LOCATED ON EACH SIDE OF THE RAMP AND WITHIN THE MARKED CROSSING.

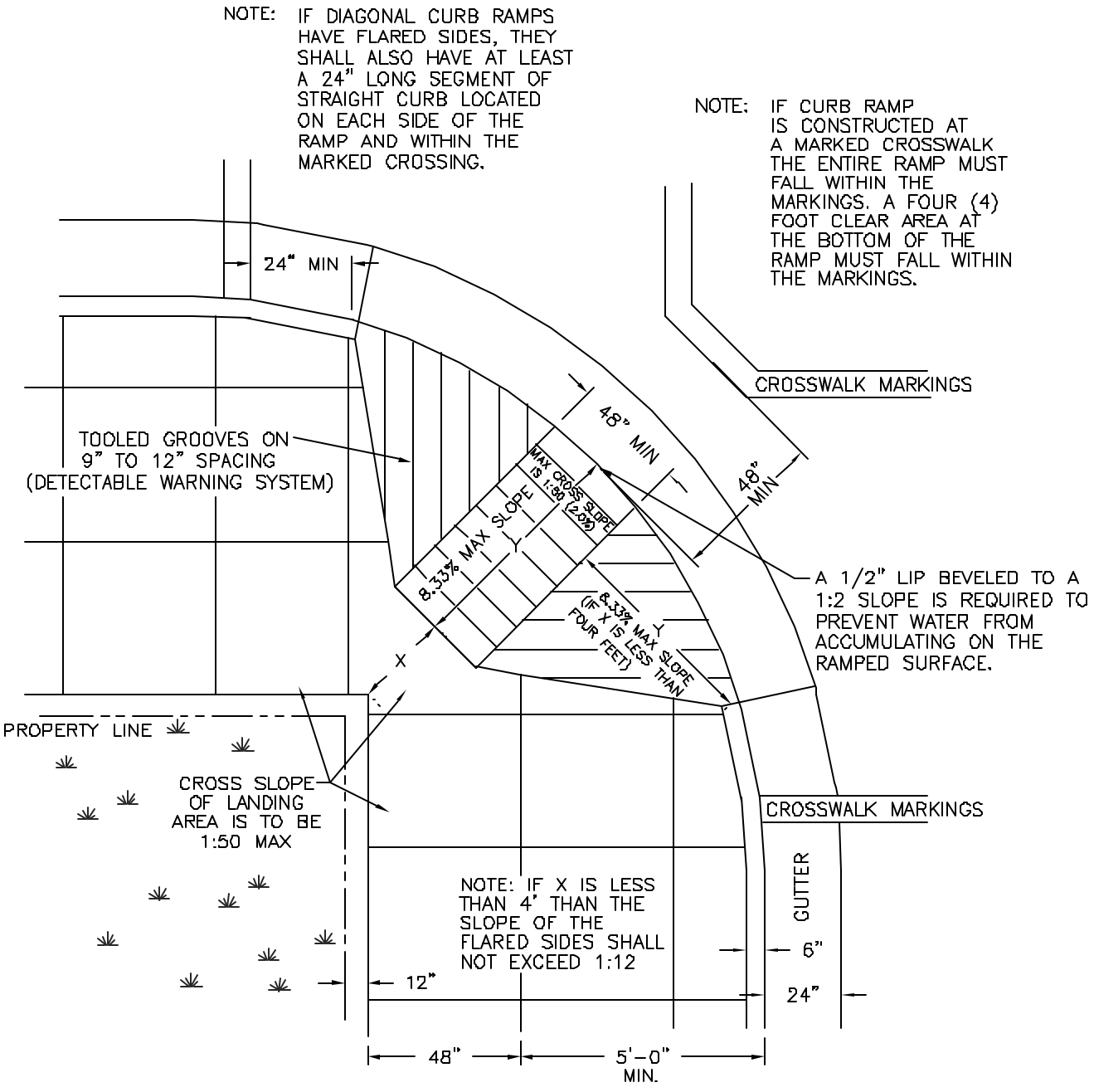
NOTE: IF CURB RAMP IS CONSTRUCTED AT A MARKED CROSSWALK THE ENTIRE RAMP MUST FALL WITHIN THE MARKINGS. A FOUR (4) FOOT CLEAR AREA AT THE BOTTOM OF THE RAMP MUST FALL WITHIN THE MARKINGS.

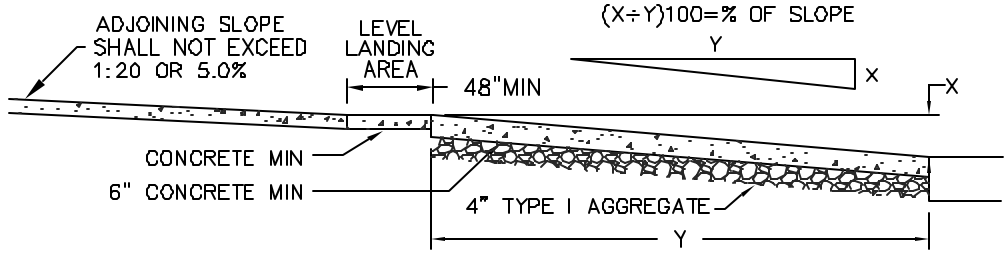




MEASUREMENT OF RAMP SLOPES

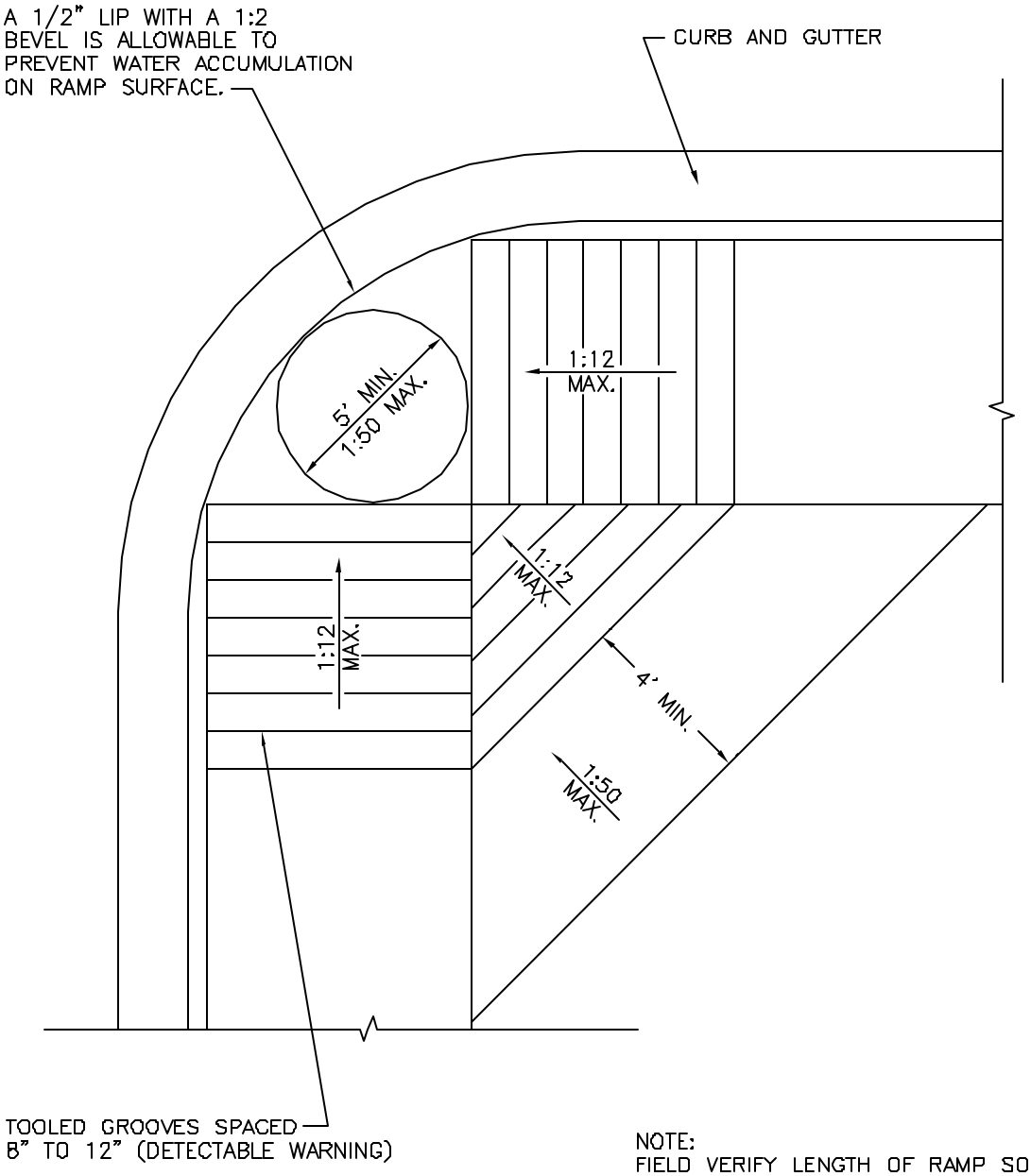
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE I	ADOPTED: 10/15/02 ST-10





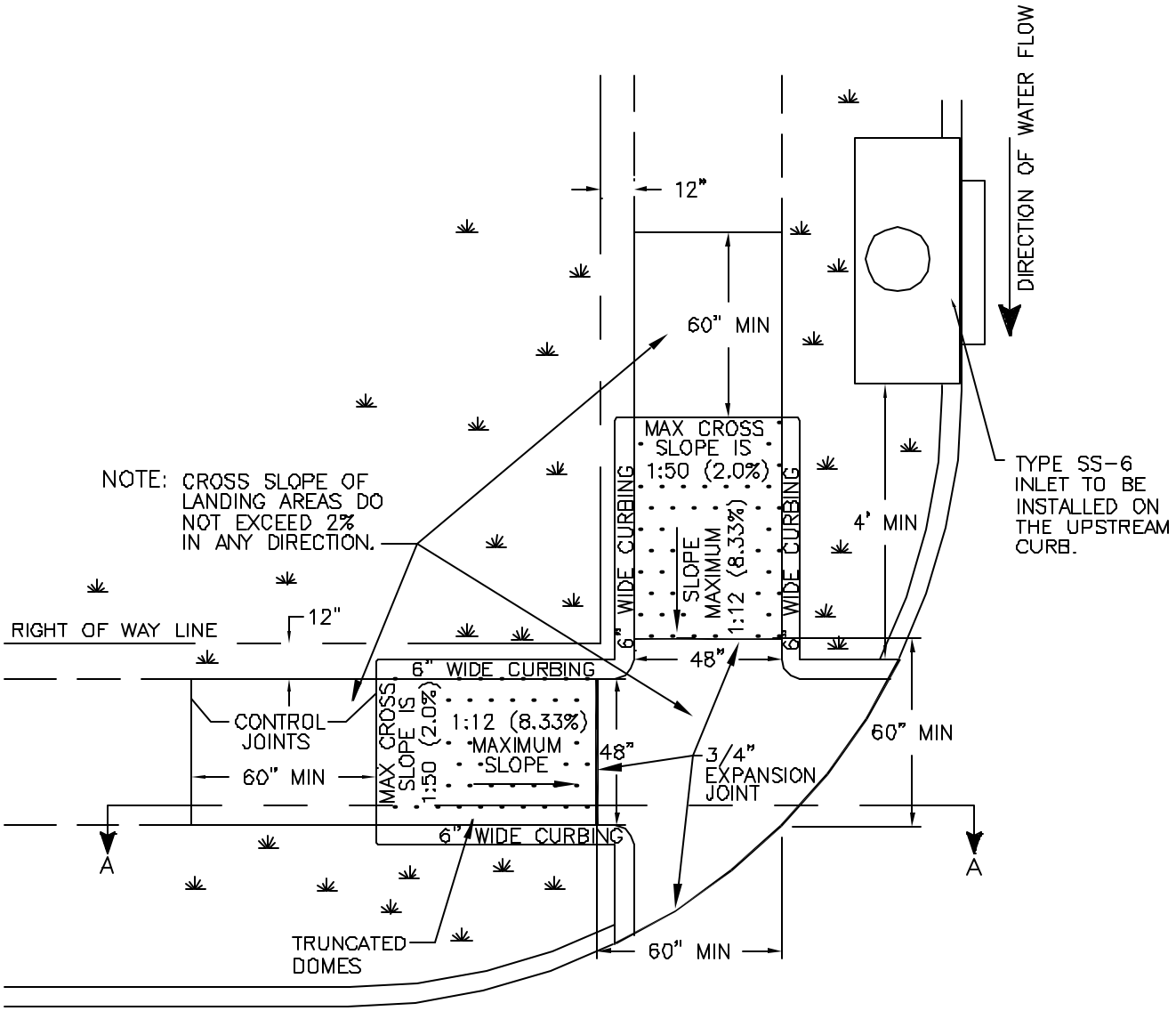
MEASUREMENT OF RAMP SLOPES

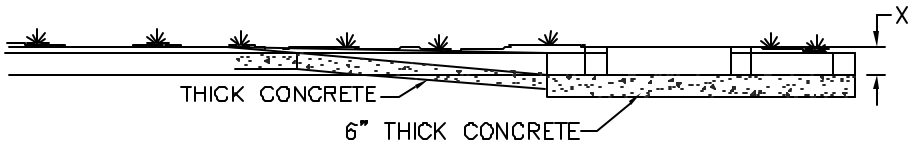
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE I–A	ADOPTED: 10/15/02 ST–11



NOTE:
FIELD VERIFY LENGTH OF RAMP SO
AS NOT TO EXCEED MAXIMUM SLOPE

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE I-B	ADOPTED: 10/15/02 ST-12



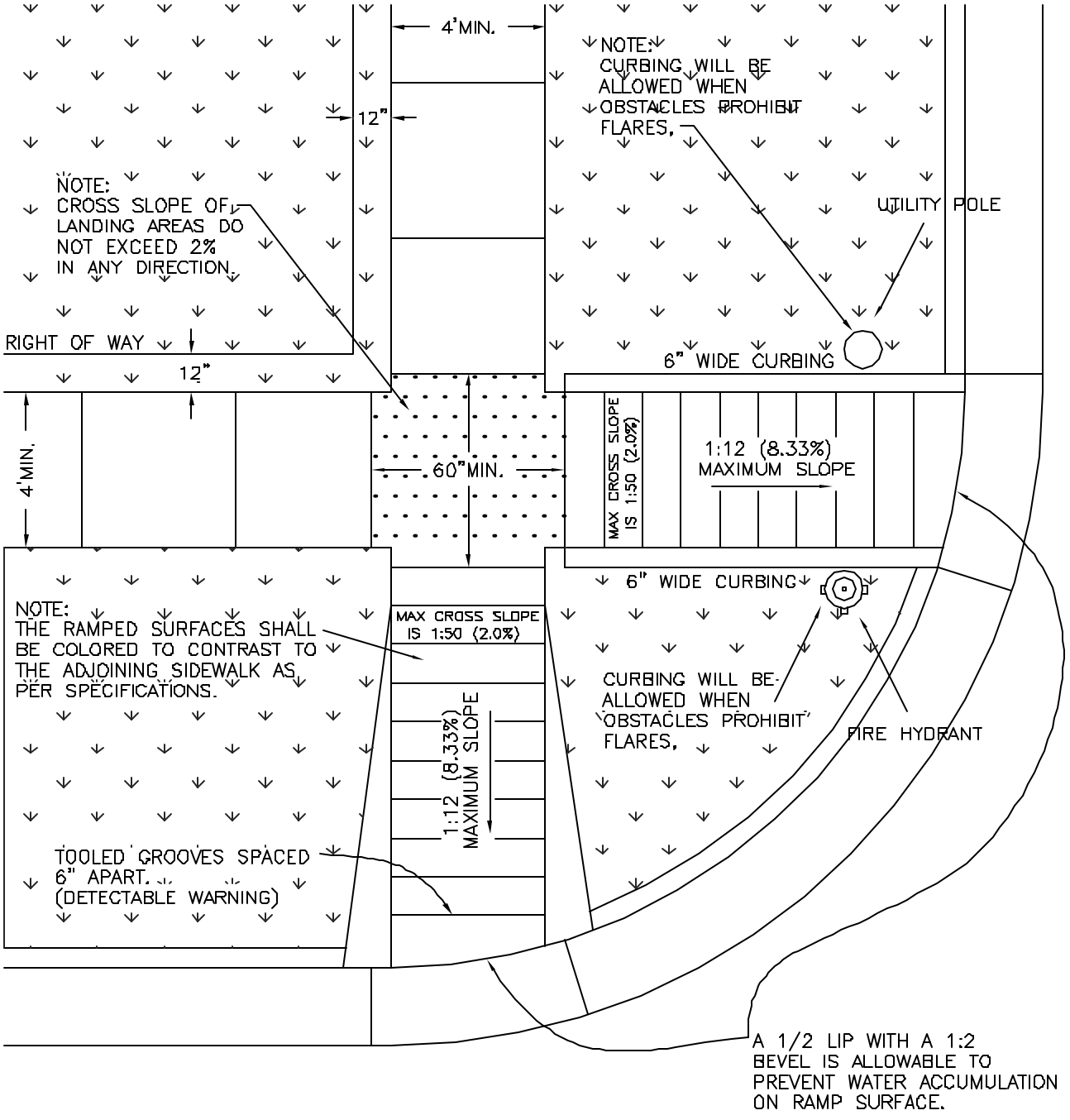


NOTE: WHEN X IS MORE THAN 6" A MAXIMUM SLOPE OF 1:12 OR 8.33% SHALL BE CONSTRUCTED.

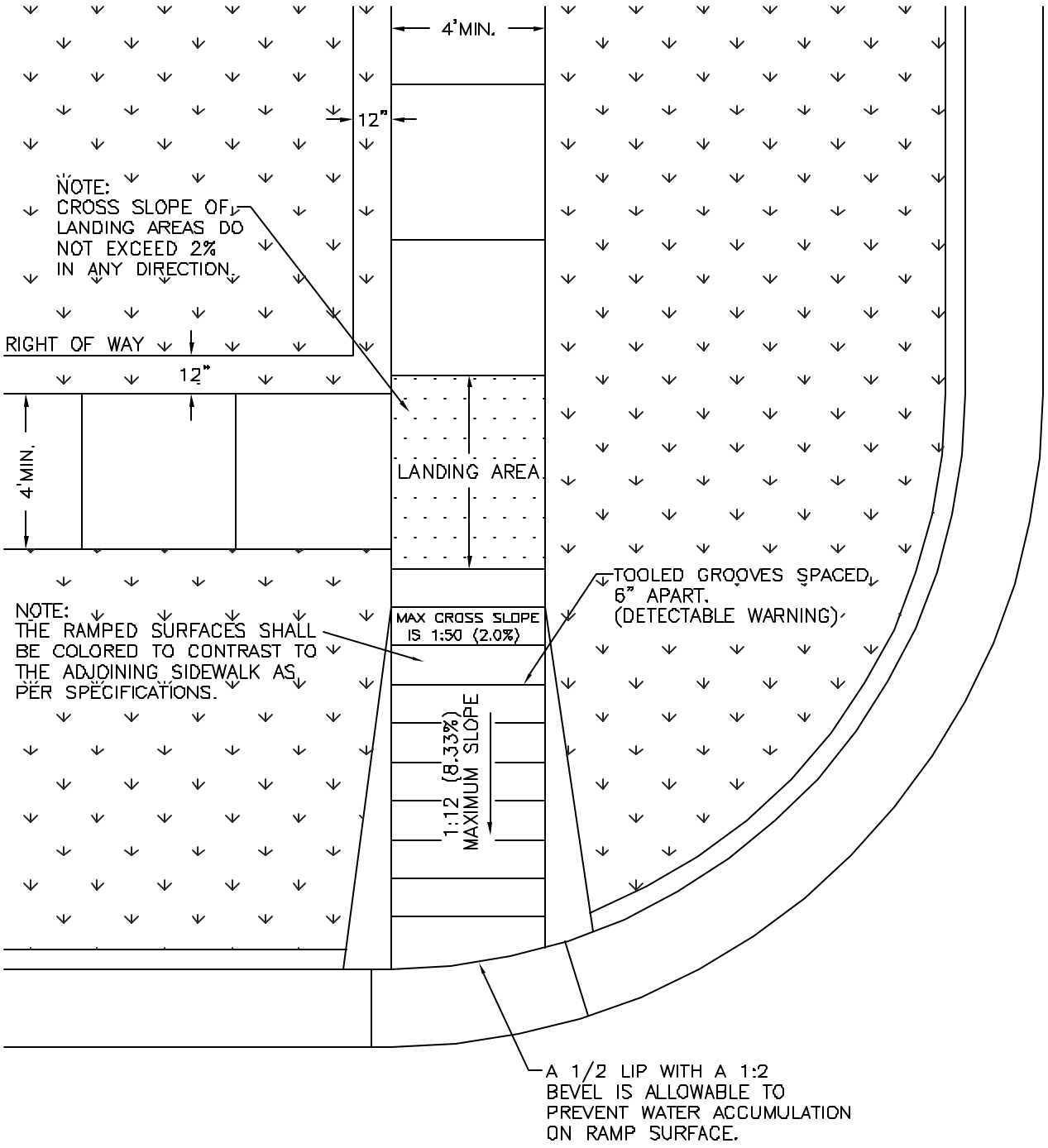
SECTION A–A

NOTE: USE CURB RAMP STYLE II WHEN DISTANCE FROM FACE OF CURB AND THE RIGHT OF WAY LINE IS LESS THAN AN ALLOWABLE DISTANCE TO INSTALL A CURB RAMP TYPE I WITH A 1 ;12 (8.33%) RUNNING SLOPE.

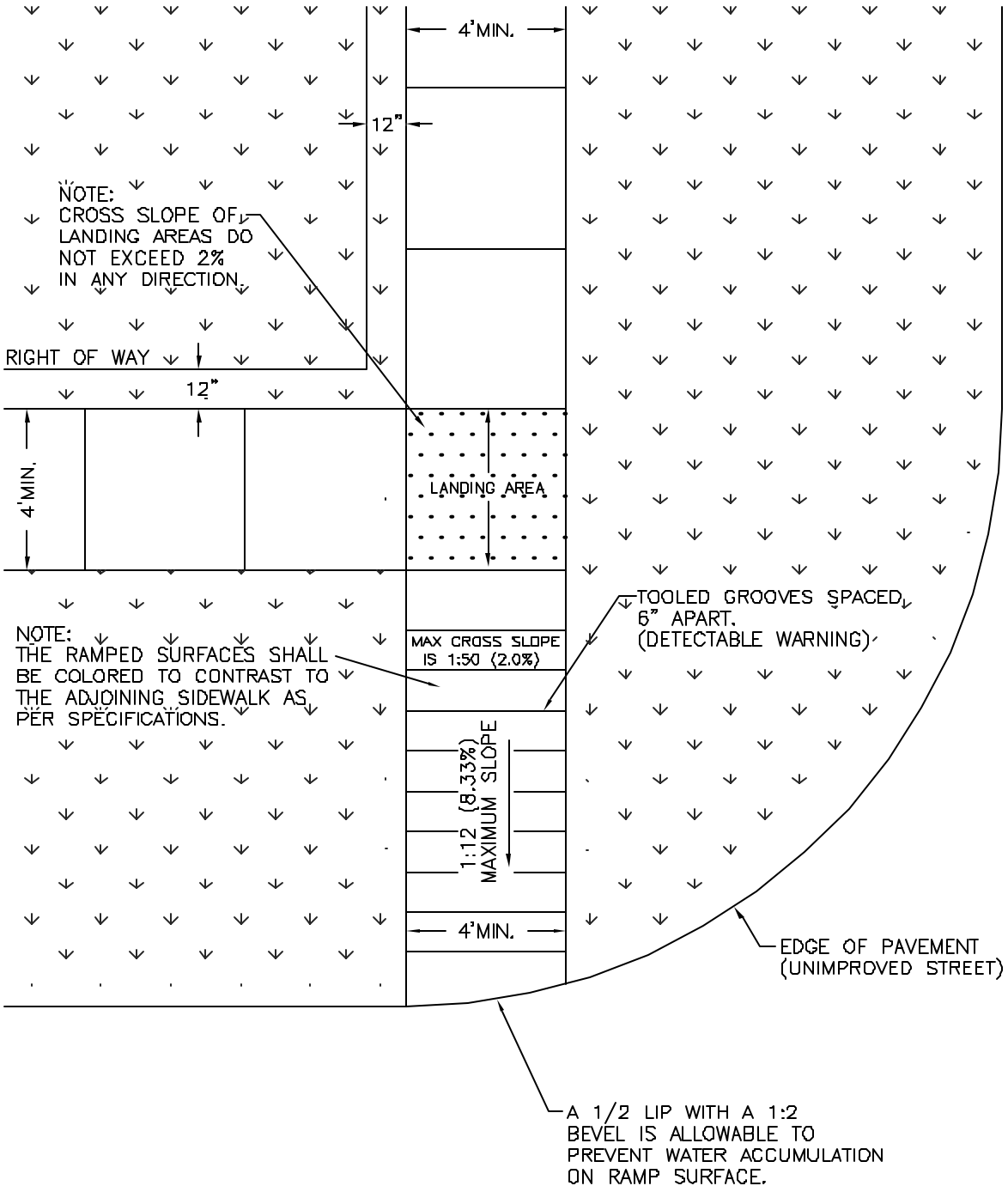
CITY OF BATTLEFIELD□ STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE II	ADOPTED: 10/15/02 ST–13



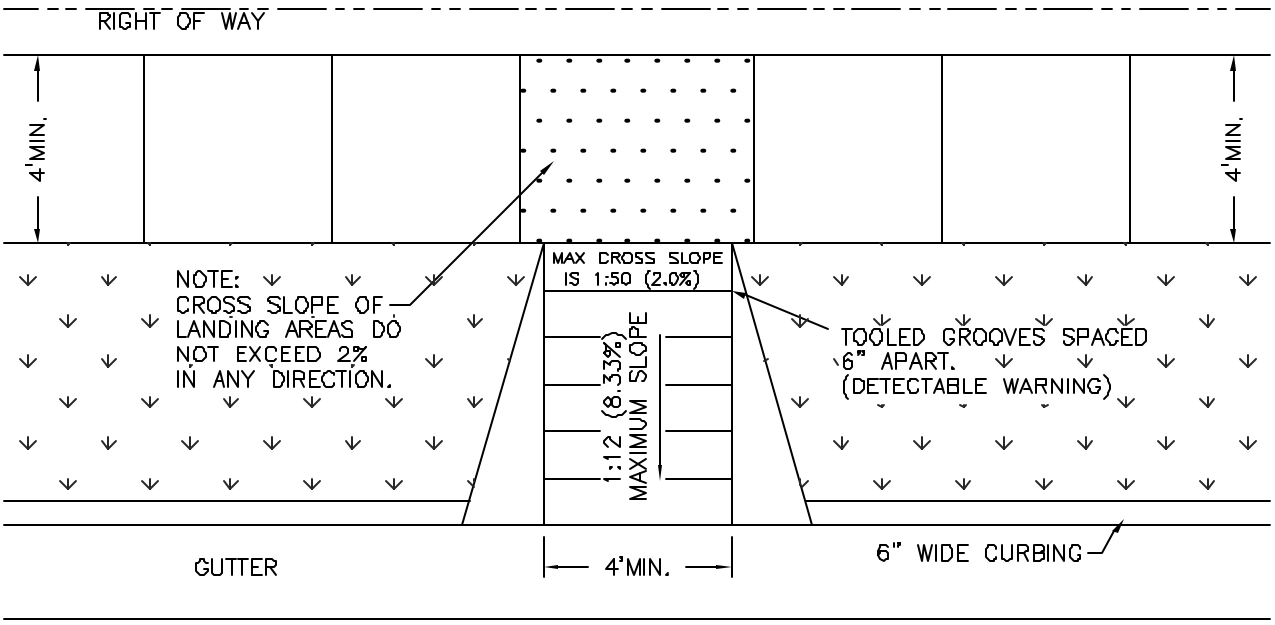
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE IV	ADOPTED: 10/15/02 ST–14



CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE IV – IMPROVED	ADOPTED: 10/15/02 ST–15



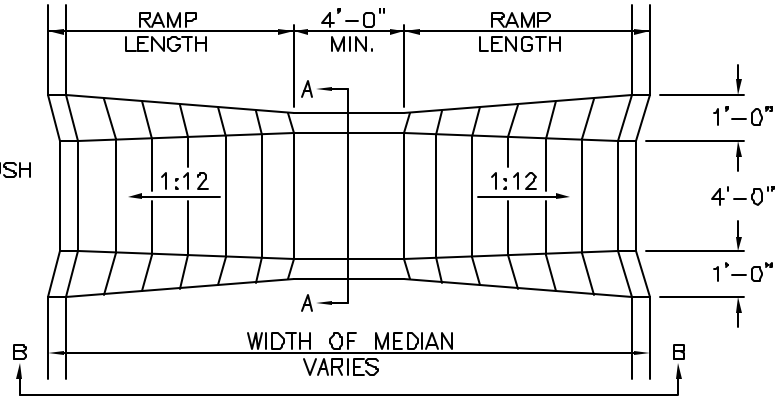
CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	CURB RAMP TYPE IV – UNIMPROVED	ADOPTED: 10/15/02 ST–16



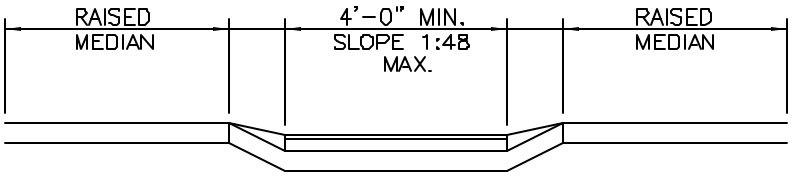
MID-STREET RAMP

SUPPLEMENTAL NOTES–
NEW CONSTRUCTION

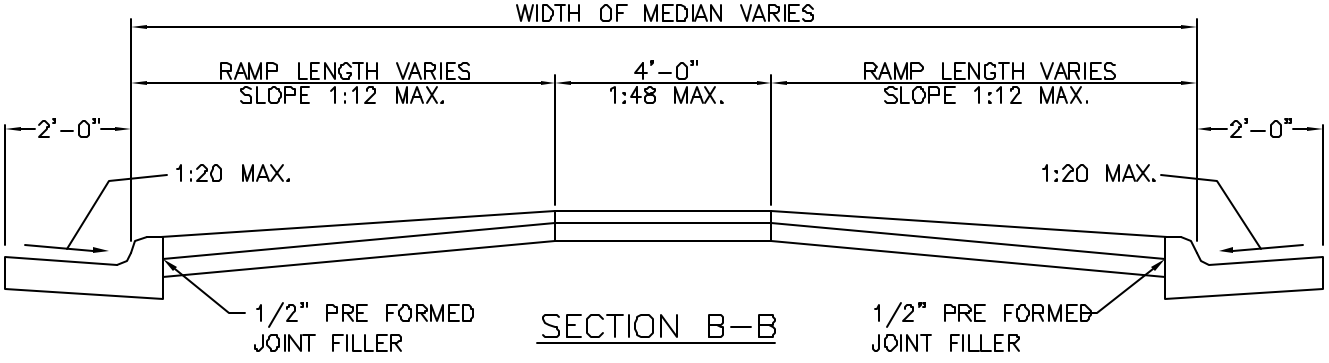
THE BOTTOM EDGE OF THE CURB RAMP SHALL BE FLUSH WITH THE EDGE OF THE ADJACENT PAVEMENT AND GUTTER.



MEDIAN RAMP



SECTION A–A



SECTION B–B

CITY OF BATTLEFIELD STANDARD DRAWINGS AND FIGURES	MISC.–STREET CURB RAMPS	ADOPTED: 10/15/02 ST–17